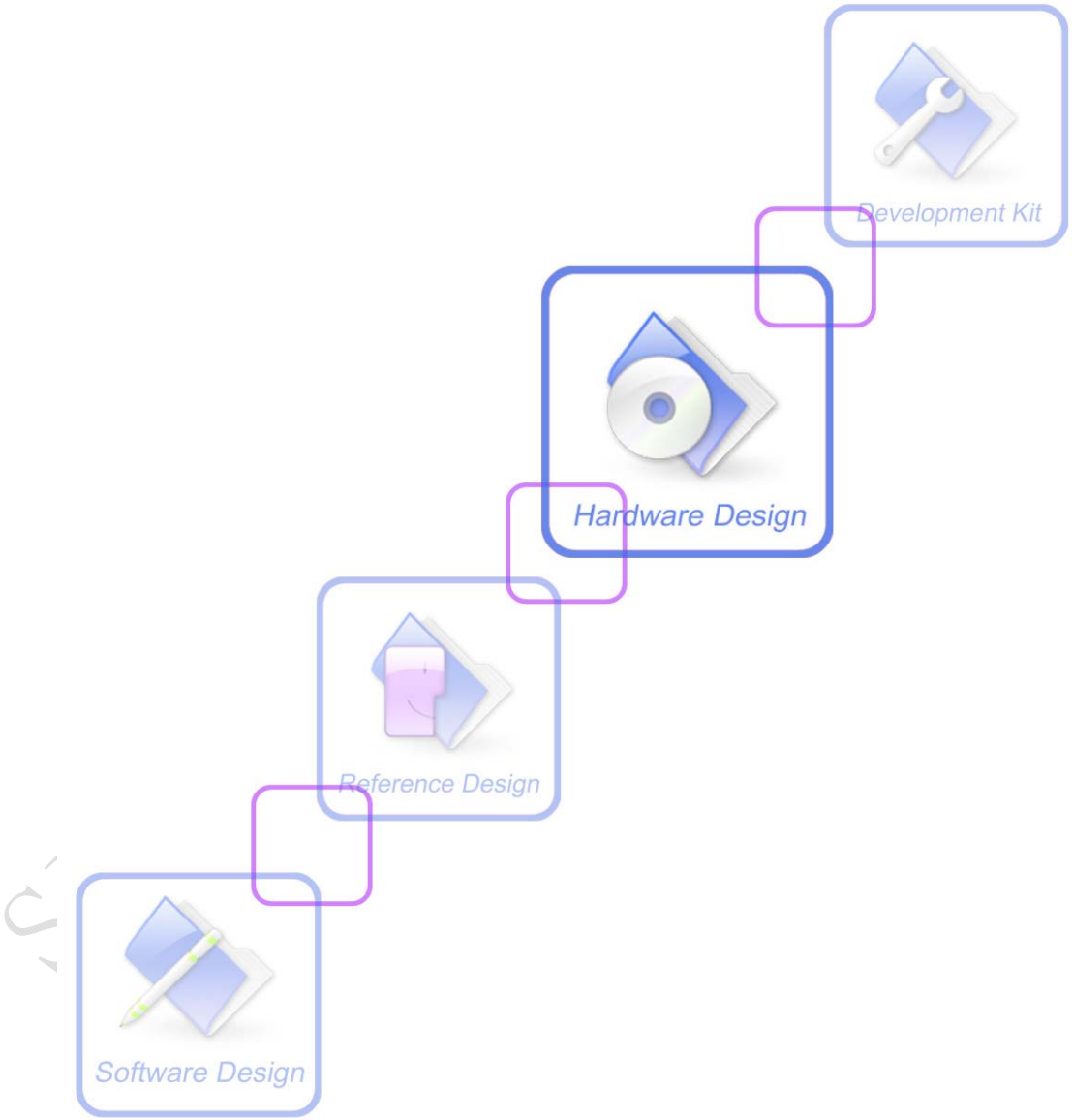
Hardware Design

SIM802_HD_V2.01



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Version history

Data	Version	Description of change	Author
2010-01-12	2.01	Origin	Jirang Feng

Scope of the document

This document is intended for the following versions of the SIMCom modules

- SIM802-A: GSM/GPRS 900/1800 MHz and 850/1900MHz, SRD RF 433MHz Version
  SIM802-B: GSM/GPRS 900/1800 MHz and 850/1900MHz, SRD RF 868MHz Version
  SIM802-C: GSM/GPRS 900/1800 MHz and 850/1900MHz, SRD RF 915MHz Version

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1 Introduction

This document describes the hardware interface of the SIMCom SIM802 module that connects to the specific application and the air interface. As SIM802 can be integrated with a wide range of applications, all functional components of SIM802 are described in great detail.
This document can help you quickly understand SIM802 interface specifications, electrical and mechanical details. With the help of this document and other SIM802 application notes and user guide, you can use SIM802 module to design and set-up mobile applications quickly.

1.1 Related documents

Table 1: Related documents

SN	Document name	Remark
[1]	SIM802_ATC	SIM802_ATC
[2]	ITU-T Draft new recommendation V.25ter:	Serial asynchronous automatic dialing and control
[3]	GSM 07.07:	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[4]	GSM 07.05:	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[5]	GSM 11.14:	Digital cellular telecommunications system (Phase 2+); Specification of the SIM Application Toolkit for the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[6]	GSM 11.11:	Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module – Mobile Equipment (SIM – ME) interface
[7]	GSM 03.38:	Digital cellular telecommunications system (Phase 2+); Alphabets and language-specific information
[8]	GSM 11.10	Digital cellular telecommunications system (Phase 2)； Mobile Station (MS) conformance specification； Part 1: Conformance specification
[9]	GSM 11.10	Digital cellular telecommunications system (Phase 2)； Mobile Station (MS) conformance specification； Part 1: Conformance specification
[10]	AN_SerialPort	AN_SerialPort

1.2 Terms and abbreviations

Table 2: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-Rate
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
BER	Bit Error Rate
BTS	Base Transceiver Station
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (typically computer, terminal, printer)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
Inorm	Normal Current
Imax	Maximum Load Current

kbps	Kilo bits per second
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MT	Mobile Terminated
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
RF	Radio Frequency
RMS	Root Mean Square (value)
RTC	Real Time Clock
Rx	Receive Direction
SIM	Subscriber Identification Module
SMS	Short Message Service
SRD	Short range device
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TX	Transmit Direction
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value

Phonebook abbreviations	
FD	SIM fix dialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ME	Mobile Equipment phonebook
RC	Mobile Equipment list of received calls
SM	SIM phonebook
DC	ME dialed calls list(+CPBW may not be applicable for this storage)(same as LD)
LA	Last Number All list (LND/LNM/LNR)
ON	SIM (or ME) own numbers (MSISDNs) list
SD	SIM service dial number
VM	SIM voice mailbox
BN	SIM barred dialed number

1.3 Safety caution

The following safety precautions must be observed during all phases of the operation. Usage, service or repair of any cellular terminal or mobile incorporating SIM802 module. Manufactures of the cellular terminal should send words the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. If not so, SIMCom does not take on any liability for customer failure to comply with these precautions.

When in a hospital or other health care facility, observe the restrictions about the use of mobiles. Switch the cellular terminal or mobile off, medical equipment may be sensitive to not operate normally for RF energy interference.

Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it be switched off. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. Forget to think much of these instructions may lead to the flight safety or offender against local legal action, or both.

Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.

Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.

Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for hands free operation. Before making a call with a hand-held terminal or mobile, park the vehicle. Road safety comes first! Do not use a hand-held cellular terminal or

GSM cellular terminals or mobiles operate over radio frequency signals and cellular networks and cannot be guaranteed to connect in all conditions, for example no mobile fee or a invalid SIM card. While y ou are in this condition and need emergent help, Please Remember using emergency calls. In order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.

Some networks do not allow for emergency call if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may have to deactivate those features before you can make an emergency call.

Also, some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

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2 Product concept

Designed for global market, SIM802 module is a complete Quad-Band GSM/GPRS solution that is also equipped with SRD RF technology and embedded SIM card IC (optional).The GSM/GPRS engine works on frequencies GSM/GPRS 900/1800 MHz and 850/1900MHz, SIM802 series features GPRS multi-slot class 10/Class 8 (the default is class 10) capability and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The SRD RF engine works on 433/868/915MHz, SRD RF supports the multi-channel choice, transparent date transfer without complex user setting.

The compact design of the SIM802 makes it easy to integrate GSM/GPRS & SRD RF as an all-in-one solution. You will save significantly both time and cost for the integration of additional hardware components.
With a tiny configuration of 33mm x 33mm x 5.2 mm, SIM802 can meet almost all the space requirement in your application, such as M2M and mobile data communication system etc.

The hardware package of 60 pins

- 12 GND Pins and 2 VBAT pins
- 1 Pin is programmable as General Purpose I/O .This gives you the flexibility to develop customized applications.
- Serial port and Debug port can help you easily develop your applications. But they can not work at the same time.
- Two audio channels include two microphone inputs and two speakers' outputs. This can be easily configured by AT command.
- LCD display interface.
- Either SIM card interface or embedded SIM card IC is optional.
- Charge interface. Charge circuit integrated inside the SIM802, it is very suitable for the battery power application.
- GSM RF and SRD RF antenna interface. Customer's antenna should be located in the customer's mainboard and connect to module's antenna pad through micro strip line or other type RF traces which impendence must be 50Ω.
- I^2C and SPI interfaces for SRD.

The SIM802 is designed with power saving technique, so that the current consumption is as low as 6mA in SLEEP mode (BS-PA-MFRMS=5, only GSM sleep mode current consumption).

The SIM802 is integrated with the TCP/IP protocol，Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is useful for those data transfer applications.

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2.1 SIM802 key features at a glance

Table 3: SIM802 key features

Feature	Implementation
Power supply	Single supply voltage 3.4V – 4.5V
Power saving	Typical power consumption in SLEEP mode to 6mA (BS-PA-MFRMS=5)
Charging	Supports charging control for Li-Ion battery
GSM frequency Bands	● SIM802 quad-band: GSM/GPRS 900/1800 MHz and 850/1900MHz. The SIM802 can search the 4 frequency bands automatically. The frequency bands also can be set by AT command. ● Compliant to GSM Phase 2/2+
GSM class	Small MS（CLASS:A,B,C,D）
Transmit power	● Class 4 (2W) at EGSM900/GSM850 ● Class 1 (1W) at DCS1800/PCS1900
GPRS connectivity	● GPRS multi-slot class 8 （optional） ● GPRS multi-slot class 10 （default) ● GPRS mobile station class B
Temperature range	● Normal operation: -30°C to +80°C ● Restricted operation: -40°C to -30°C and +80°C to +85°C(1) ● Storage temperature: -45°C to +90°C
DATA GPRS: CSD:	● GPRS data downlink transfer: max. 85.6 kbps ● GPRS data uplink transfer: max. 42.8 kbps ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● SIM802 supports the protocols PAP (Password Authentication Protocol) usually used for PPP connections. ● The SIM802 integrates the TCP/IP protocol. ● Support Packet Switched Broadcast Control Channel (PBCCH) ● CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent ● Unstructured Supplementary Services Data (USSD) support
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card
FAX	Group 3 Class 1
SIM interface	Support SIM card: 1.8V ,3V
External antenna	Connected via 50 Ohm antenna connector or antenna pad
Audio features	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10)

	● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive multi rate (AMR) ● Echo Cancellation
Serial interface and Debug interface	● Serial Port: Seven lines on Serial Port Interface ● Serial Port can be used for CSD FAX, GPRS service and sending AT command of controlling module. ● Debug port: provide two lines on Serial Port Interface /TXD and /RXD ● Debug port is only used for debugging
Phonebook management	Support phonebook types: SM, FD, LD, MC, RC, ON, ME,BN,VM,LA,DC,SD
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Implemented
Timer function	Programmable via AT command
Physical characteristics	Size: 33±0.15 x 33±0.15 x 5.15±0.15 mm Weight: 10g
Firmware upgrade	Firmware upgrade over serial interface
SRD frequency Bands	SIM802-A :433MHz– 434.79MHz SIM802-B: 863MHz – 870MHz SIM802-C: 902MHz – 928MHz
SRD modulation schemes	GFSK
SRD frequency interval	100KHz
SRD maximum transmit power	18dBm
SRD receive sensitivity	-118dBm@2400bps
SRD air interface date rate	2400 – 128000bps
SRD TX current consumption	100mA@18dBm (peak value)
SRD RX current consumption	29mA

Table 4: Coding schemes and maximum net data rates over air interface

Coding scheme	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	9.05kbps	18.1kbps	36.2kbps
CS-2:	13.4kbps	26.8kbps	53.6kbps
CS-3:	15.6kbps	31.2kbps	62.4kbps
CS-4:	21.4kbps	42.8kbps	85.6kbps

2.2 SIM802 functional diagram

The following figure shows a functional diagram of the SIM802 and illustrates the mainly functional part:

- The GSM baseband engine
- Flash and SRAM
- The GSM radio frequency part
- The GSM antenna interface
- The SRD radio frequency part
- The SRD RF antenna interface
- The embedded SIM card IC (optional)
- The other external interfaces

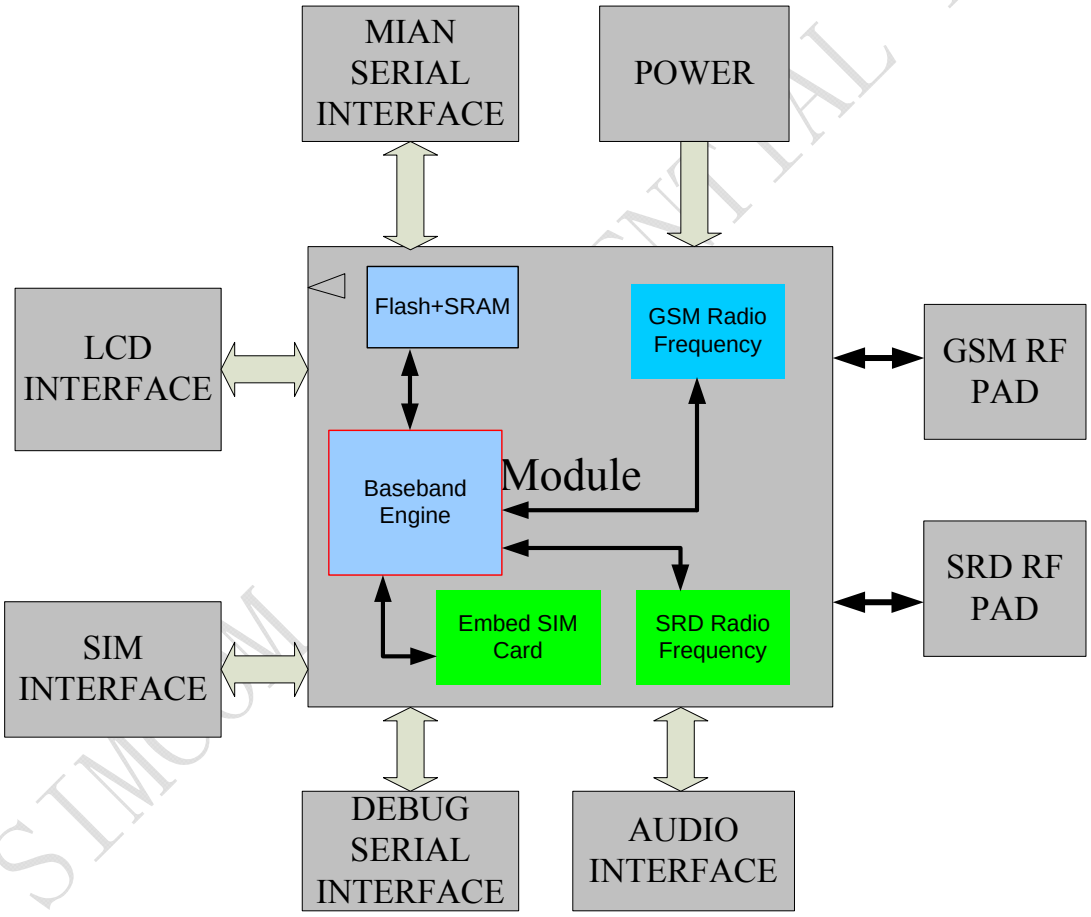

Figure 1: SIM802 functional diagram

2.3 SIM802 evaluation board

In order to help you on the application of SIM802, SIMCom can supply an Evaluation Board (EVB) that interfaces the SIM802 directly with appropriate power supply, SIM card holder, the main serial port and debug serial port, handset port, LCD (optional), antenna and all GPIO of the SIM802.

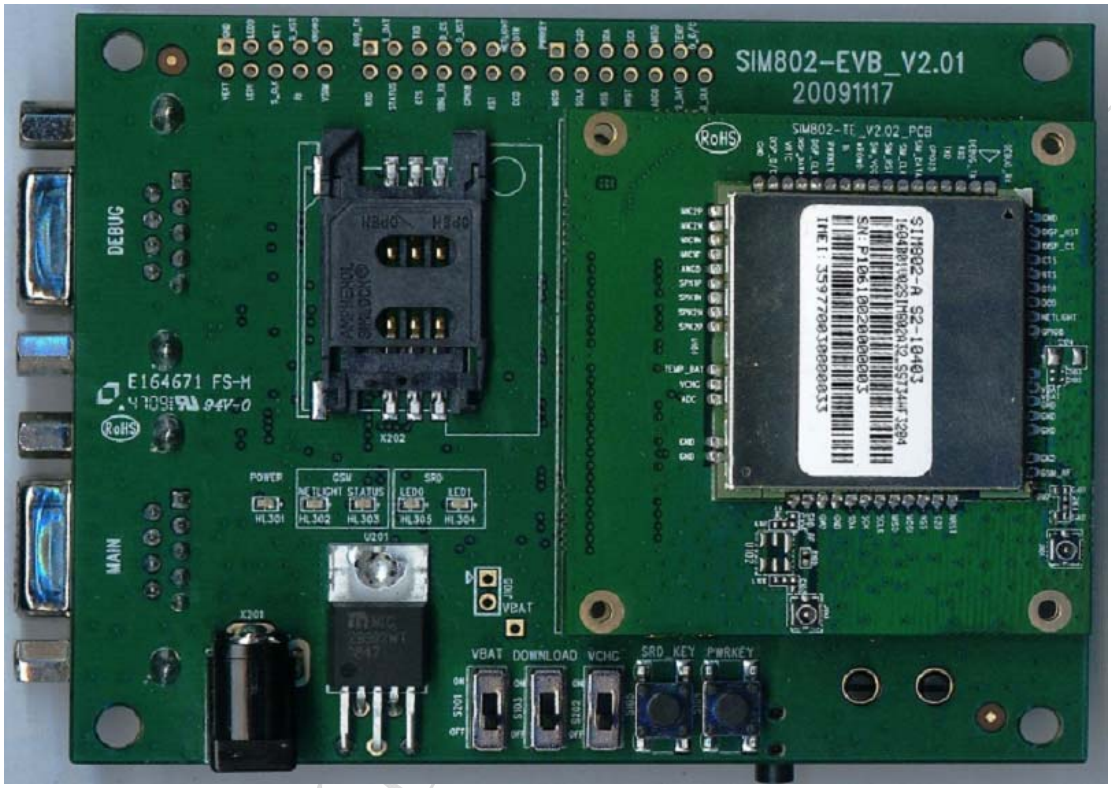

Figure 2: Top view of SIM802 EVB

For details please refer to the *SIM802-EVB_UGD* document.

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3 Application interface

All hardware interfaces are described in detail in following chapters:

- Power supply and charging control *(see Chapters 3.3 and 3.5)*
- Provide main serial interface and debug serial interface *(see chapter3.9)*
- Two analog audio interfaces *(see chapter 3.10)*
- SIM interface *(see chapter 3.11)*
- LCD interface *(see chapter 3.12)*
- GPIO interface *(see chapter 3.13)*
- ADC interface *(see chapter 3.14)*
- Buzzer interface *(see chapter 3.18)*

3.1 SIM802 Pin description

Table 5: Pin description

Power supply				
Pin Name	**I/O**	**Description**	**DC characteristics**	**Comment**
VBAT	Power	2 VBAT pins are dedicated to connect the supply voltage. The power supply of SIM802 has to be a single voltage source of VBAT= 3.4V...4.5V. It must be able to provide sufficient current in a transmit burst which typically rises to 2A.Mostly, these 2 pins are voltage input, however ,when use the charge circuit to charge the battery ,these pins become the current output, select one of these pins as the charge current output Pin	Vmax= 4.5V Vmin=3.4V Vnorm=4.0V	
VRTC	Power	Current input for RTC when the battery is not supplied for	Vmax=2.0V Vmin=1.2V	Do not keep pin open, it should be

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		the system. Current output for backup battery when the main battery is present and the backup battery is in low voltage state.	Vnorm=1.8V Iout(max)= 20uA Iin=5 uA	connected to a battery or a capacitor.
VCHG	I	Voltage input for the charge circuit, as the signal for detecting the charger connecting	Vmax=5.25V Vmin=1.1* VBAT Vnorm=5.1V Imax=650mA	If unused keep pin open
GND	ground	Digital ground		
Power on or power off				
Pin name	**I/O**	**Description**	**DC characteristics**	**Comment**
PWRKEY	I	Press the key , the PWRKEY get a low level voltage for user to power on or power off the system, the user should keep pressing the key for a moment when power on or power off the system. Because the system need margin time assert the software.	VILmax=0.2*VBAT VIHmin=0.6*VBAT VImax=VBAT	Pull up to VBAT inside.
Audio interfaces				
Pin name	**I/O**	**Description**	**DC characteristics**	**Comment**
MIC1P MIC1N	I	Positive and negative voice band input	Characteristics refer to chapter 3.10	If unused keep pins open
MIC2P MIC2N	I	Auxiliary positive and negative voice band input		
SPK1P SPK1N	O	Positive and negative voice band output		
SPK2P SPK2N	O	Auxiliary positive and negative voice band output		
AGND		Analog ground		Separate ground connection for external audio circuits. If unused, it should be connected to GND
General purpose input/output				

Pin name	I/O	Description	DC characteristics	Comment
STATUS	O	Indicate work status	VOLmin=GND VOLmax=0.2V VOHmin= 2.93V-0.2 VOHmax= 2.93V	If unused keep pins open
GPIO	I/O	General Input Output Port		
DISP_DATA	I/O	Display interface		If unused keep pins open
DISP _CLK	O			
DISP _CS	O			
DISP _D/C	O			
DISP _RST	O			
KBR0	I			Pull up inside, if unused keep pin open
Main serial interface				
Pin name	**I/O**	**Description**	**DC characteristics**	**Comment**
RXD	I	Receive data	VILmin=0V VILmax=0.3*2.93V VIHmin=0.7*2.93V VIHmax= 2.93V+0.3 VOLmin=GND VOLmax=0.2V VOHmin= 2.93V-0.2 VOHmax= 2.93V	If only use TXD, RXD, GND three pins to communicate, RTS Pin connect to GND directly. DTR Pin is pulled up inside. If unused keep pins open
DTR	I	Data terminal Ready		
TXD	O	Transmit data		
RTS	I	Request to send		
CTS	O	Clear to send		
RI	O	Ring indicator		
DCD	O			
Debug serial interface				
Pin name	**I/O**	**Description**	**DC characteristics**	**Comment**
DBG_TXD	O	Serial interface for debug only		If unused keep pins open
DBG_RXD	I			
SIM interface				
Pin Name	**I/O**	**Description**	**DC characteristics**	**Comment**
SIM_VDD	O	Voltage supply for SIM card	The voltage can be select by software either 1.8V or 3V	
SIM_DATA	I/O	SIM data output	VILmin=0V VILmax=0.3*SIM_VDD VIHmin=0.7*SIM_	All signals of SIM interface are protected against ESD with a TVS
SIM_CLK	O	SIM clock		
SIM_RST	O	SIM reset		

			VDD VIHmax= SIM_VDD+0.3 VOLmin=GND VOLmax=0.2V VOHmin= SIM_VDD-0.2 VOHmax= SIM_VDD	diode array.
ADC				
Pin Name	**I/O**	**Description**	**DC characteristics**	**Comment**
ADC0	I	General purpose analog to digital converter.	Input voltage value scope 0V to 2.4V	If unused keep pins open
TEMP_BAT	I	Measure the battery temperature		
SRD interface				
Pin name	**I/O**	**Description**	**DC characteristics**	**Comment**
SDA	O/I	I^2C data , default for GPIO	VOLmin=GND VOLmax=0.2V VOHmin= 3.3V -0.2 VOHmax= 3.3V	If unused keep pins open
SCK	O	I^2C clock , default for GPIO		
NSS	O	SPI chip select , default for GPIO		
SCLK	O	SPI clock , default for GPIO		
MOSI	O	Master out slave in, default for GPIO		
MISO	I	Master in slave out, , default for GPIO		
C2D		Reserve		
NRST		Reserve		

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3.2 Operating modes

The table below briefly summarizes the various operating modes referred to in the following chapters.

Table 6: Overview of operating modes

Mode		Function
Normal operation	GSM/GPRS SLEEP	Module will automatically go into SLEEP mode if DTR is set to high level and there is no on air or audio activity is required and no hardware interrupt (such as GPIO interrupt or data on serial port). In this case, the current consumption of module will reduce to the minimal level. During sleep mode, the module can still receive paging message and SMS from the system normally.
	GSM IDLE	Software is active. Module has been registered to the GSM network, and the module is ready to send and receive.
	GSM TALK	Connection is going on between two subscribers. In this case, the power consumption depends on network settings such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS STANDBY	Module is ready for GPRS data transfer, but no data is currently sent or received. In this case, power consumption depends on network settings and GPRS configuration (e.g. multi-slot settings).
	GPRS DATA	There is GPRS data in transfer (PPP or TCP or UDP). In this case, power consumption is related with network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multi-slot settings).
	SRD DATA	There are two statuses: receive or transmit .Transmitting power levels can be set up to 4 levels. Power consumption is related with transmitting power levels. For details please refer to *document [1]*
POWER DOWN		Normal shutdown by sending the “AT+CPOWD” command or using the PWRKEY. The power management ASIC disconnects the power supply from the baseband part of the module， and only the power supply for the RTC is remained. Software is not active. The serial interfaces are not accessible. Operating voltage (connected to BATT) remains applied.
Minimum functionality mode (without remove power supply)		Use the “AT+CFUN” command can set the module to a minimum functionality mode without remove the power supply. In this case, the GSM RF part of the module will not work or the SIM card will not be accessible, or both RF part and SIM card will be closed all, and the

	serial interfaces is still accessible. The power consumption in this case is very low.
Alarm mode	RTC alert function launches this restricted operation while the module is in POWER DOWN mode. SIM802 will not be registered to GSM network and only parts of AT commands can be available.
GHOST Mode (Charge-only mode)	GHOST mode means off and charging mode. In this mode, the module can not be registered to GSM network and only limited AT commands can be accessible, the following way will launch GHOST mode: ● From POWER DOWN mode: Connect charger to the module's VCHG Pin and VBAT Pin while SIM802 is power down. ● From Normal mode: Connect charger to the module's VCHG Pin and VBAT Pin, then power down the module by "AT+CPOWD" ● From Normal mode: Connect charger to the module's VCHG Pin and VBAT Pin, then press the PWRKEY get a low level voltage for about 2s.
Charge mode during normal operation	Start charging while the module is in normal mode including: SLEEP, IDLE, TALK, GPRS STANDBY and GPRS DATA

3.3 Power supply

The power supply of VBAT voltage range is from 3.4 to 4.5V .The ripple in a transmitting burst may cause voltage drops when current consumption rise to typical peaks of 2A, So the power supply must be able to provide sufficient current up to 2A.

For the VBAT input, a local bypass capacitor is recommended. For example, a lower cost choice may be a 100 μF tantalum capacitor (low ESR) with a small (0.1 μF to 1 μF) ceramic in parallel, which is illustrated as figure 3. The capacitors should be put as closer as possible to the SIM802 VBAT pins.

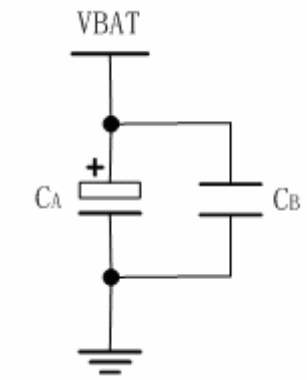

Figure 3: VBAT input

The circuit design of the power supply depends strongly from the power source where this power

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is drained. The following figure is the reference design of +5V input source power supply. The designed output for the power supply is 4V, thus a linear regulator can be used. If there's a big difference between the input source and the desired output (VBAT), a switching converter power supply will be preferable because of its better efficiency especially with the 2A peak current in burst mode of the module.

The single 3.6V Li-Ion cell battery type can be connected to the power supply of the SIM802 VBAT directly. But the Ni_Cd or Ni_MH battery types must be used carefully, since their maximum voltage can rise over the absolute maximum voltage for the module and damage it.

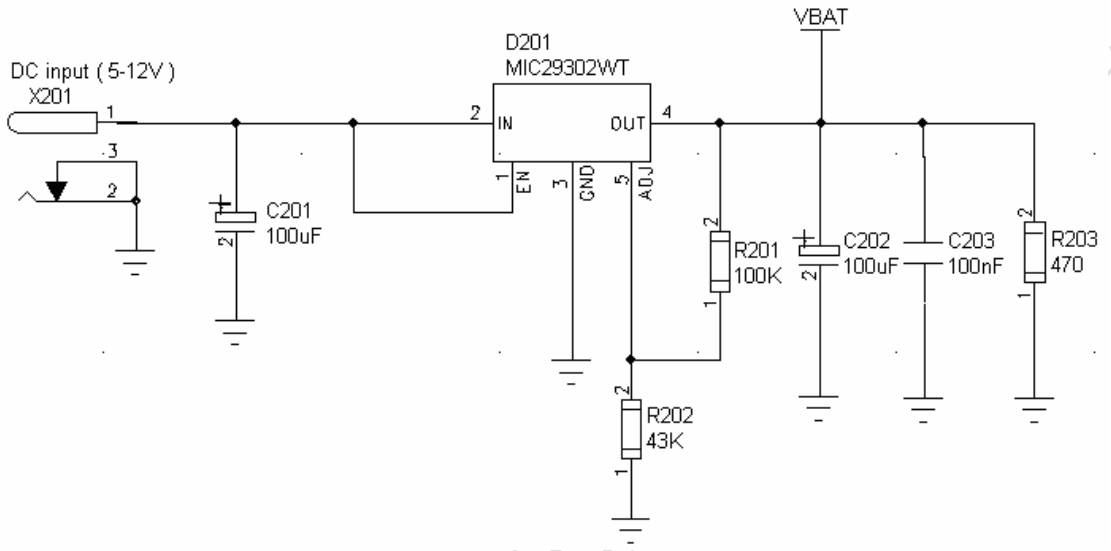

Figure 4: Reference circuit of the source power supply input

The following figure is the VBAT voltage ripple wave at the maximum power transmit phase, the test condition is VBAT=4.0V, VBAT maximum output current =2A, C_A=100μF tantalum capacitor (ESR=0.7Ω) and C_B=1μF.

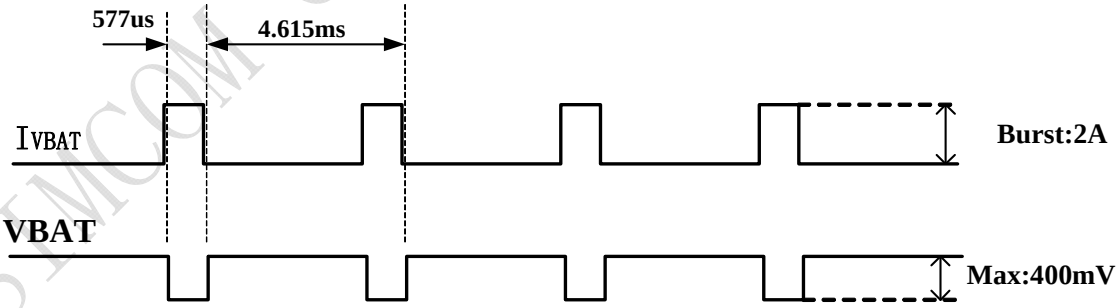

Figure 5: VBAT voltage drop during transmit burst

3.3.1 Power supply pins

Two VBAT pins of SIM802 are dedicated to connect the supply voltage. Twelve GND pins and

one analog GND pins are recommended for grounding. The VCHG Pin serves as a control signal for charging a Li-Ion battery. VRTC Pin can be used to back up the RTC.

3.3.2 Minimizing power losses

Please pay special attention to the supply power when you are designing your applications. Please make sure that the input voltage will never drop below 3.4V even in a transmitting burst during which the current consumption may rise up to 2A. If the power voltage drops below 3.4V, the module may be switched off. You should also take the resistance from the power supply lines on the host board or from battery pack into account.

3.3.3 Monitoring power supply

To monitor the supply voltage, you can use the "AT+CBC" command which include three parameters: charging state, voltage percentage and voltage value (in mV). It returns charge state，the battery voltage 1-100 percent of capacity and actual value measured at VBAT and GND.

The voltage is continuously measured at intervals depending on the operating mode. The displayed voltage (in mV) is averaged over the last measuring period before the AT+CBC command is executed.

For details please refer to *document [1]*

3.4 Power up/down scenarios

3.4.1 Turn on SIM802

SIM802 can be turned on by various ways, which are described in following chapters:

- Via PWRKEY Pin: starts normal operating mode (see chapter 3.2);
- Via VCHG Pin: starts GHOST modes (see chapter 3.4.1.2);
- Via RTC interrupt: starts ALARM modes (see chapter 3.4.1.4)

Note: The AT command must be set after the SIM802 is power on and Unsolicited Result Code "RDY" is received from the serial port. However if the SIM802 is set autobauding, the serial port will receive nothing. The AT commands can be set in 2-3s after the SIM802 is power on. You can use AT+IPR=x;&W to set a fixed baud rate and save the configuration to non-volatile flash memory. After the configuration is saved as fixed baud rate, the Code "RDY" should be received from the serial port all the time that the SIM802 is power on. Please refer to the chapter AT+IPR in document [1].

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3.4.1.1 Turn on SIM802 using the PWRKEY Pin (Power on)

Turn on the SIM802 by driving the PWRKEY to a low level voltage for a period time. This Pin is pulled up to VBAT in the module. The simple circuit illustrates as the following figures.

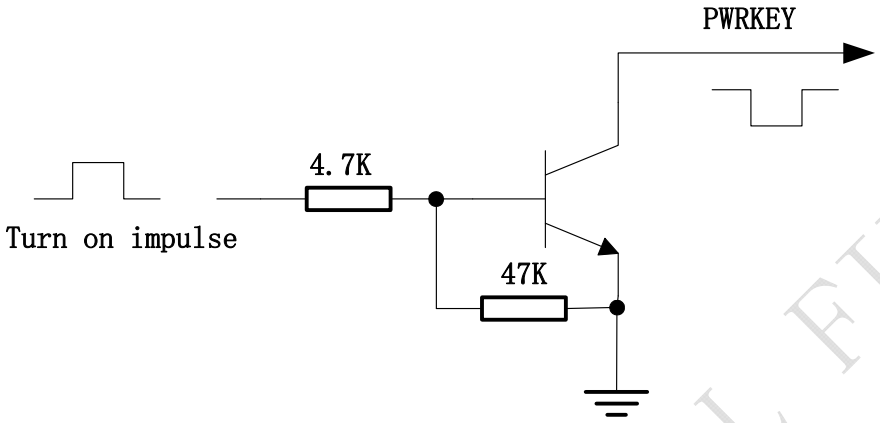

Figure 6: Turn on SIM802 using driving circuit

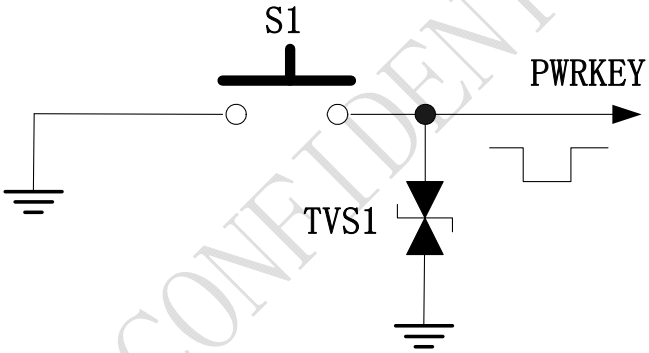

Figure 7: Turn on SIM802 using button

The power on scenarios illustrates as following figure.

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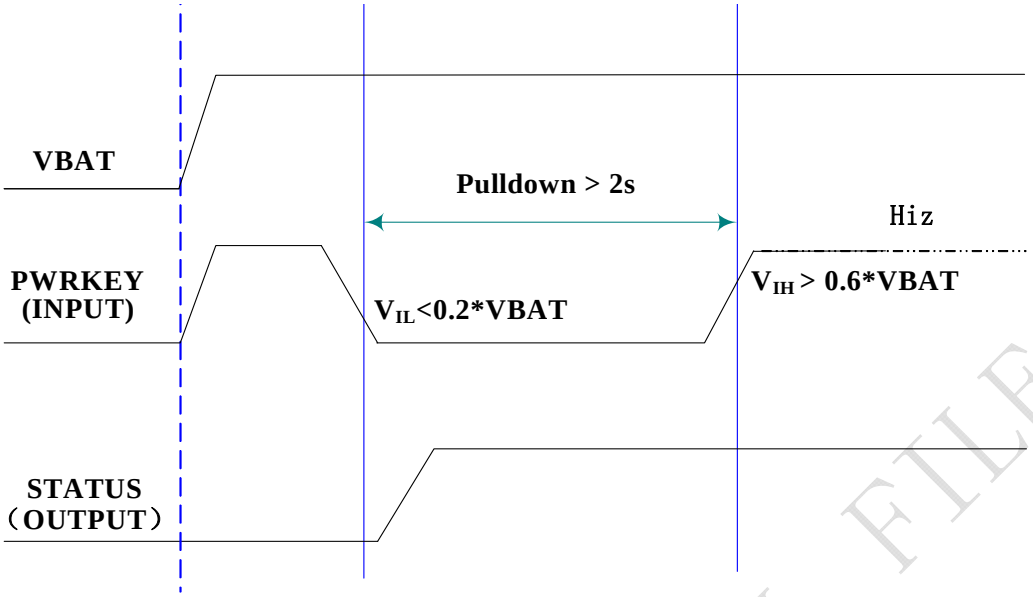

Figure 8 Timing of turn on system

When power on procedure completed, SIM802 will send out following result code to indicate the module is ready to operate, when set as fixed baud rate. STATUS Pin will drive to 2.8V and keep this level when in work mode. If configured to a fixed baud rate, SIM802 will send the result code "RDY" to indicate that it is ready to operate. This result code does not appear when autobauding is active.

3.4.1.2 Turn on the SIM802 using the VCHG signal

As described in chapter 3.4, charger can be connected to SIM802's VCHG Pin regardless of the module's operating mode.

If the charger is connected to the module's VCHG Pin while SIM802 is in POWER DOWN mode, SIM802 will go into the GHOST mode (Off and charging). In this mode, the module will not register to network, and only a few AT commands can work in this mode. For detailed information please refers to chapter 3.5.

When module is powered on using the VCHG signal, SIM802 sends out result code as following when fixed baud rate:

RDY

GHOST MODE

In GHOST mode, by driving the PWRKEY to a low level voltage for period time (Please refer to the power on scenarios in 3.4), SIM802 will power up and go into charge mode (charging in normal mode), all operation and AT commands can be available. In this case, SIM802 will send out result code as following:

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From GHOST MODE to NORMAL MODE

3.4.1.3 Turn on SIM802 using the RTC (Alarm mode)

Alarm mode is a power-on approach by using the RTC. The alert function of RTC makes the SIM802 wakeup while the module power off. In alarm mode, SIM802 will not register to GSM network and the software protocol stack is closed. Thus the parts of AT commands related with SIM card and Protocol stack will not be accessible, and the others can be used as well as in normal mode.

Use the AT+CALARM command to set the alarm time. The RTC remains the alarm time if SIM802 is power down by "AT+CPOWD=1" or by PWRKEY Pin. Once the alarm time expired and executed, SIM802 will go into the Alarm mode. In this case, SIM802 will send out an Unsolicited Result Code (URC) when set as fixed baud rate:

RDY

ALARM MODE

During Alarm mode, use AT+CFUN command to query the status of software protocol stack; it will return 0 which indicates that the protocol stack is closed. Then after 90s, SIM802 will power down automatically. However, during Alarm mode, if the software protocol is started by AT+CFUN=1 command, the process of automatic power down will not be available. In ALARM mode, driving the PWRKEY to a low level voltage for a period time will cause SIM802 to be powered down. (Please refer to the power down scenarios).

The table follow briefly summarizes the AT commands that are used usually during alarm mode, for details of the instructions refer to *document [1]*:

Table 7: AT commands used in Alarm mode

AT command	Use
AT+CALARM	Set alarm time
AT+CCLK	Set data and time of RTC
AT+CPOWD	Power down
AT+CFUN	Start or close the protocol stack

3.4.2 Turn off SIM802

Following procedure can be used to turn off the SIM802:

- Normal power down procedure: Turn off SIM802 using the PWRKEY Pin
- Normal power down procedure: Turn off SIM802 using AT command
- Under-voltage and over-voltage automatic shutdown: Take effect if under-voltage or

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over-voltage is detected

- Over-temperature or under-temperature automatic shutdown: Take effect if over-temperature or under-temperature is detected

3.4.2.1 Turn off SIM802 using the PWRKEY Pin (Power down)

You can turn off the SIM802 by driving the PWRKEY to a low level voltage for a period time. The power down scenarios illustrate as figure 9.

This procedure lets the module log off from the network and allows the software to enter into a secure state and saves data before completely disconnecting the power supply.

Before the completion of the switching off procedure the module will send out result code:

POWER DOWN

After this moment, the AT commands can not be executed. Module enters the POWER DOWN mode, only the RTC is still active. POWER DOWN can also be indicated by STATUS Pin, which is a low level voltage in this mode.

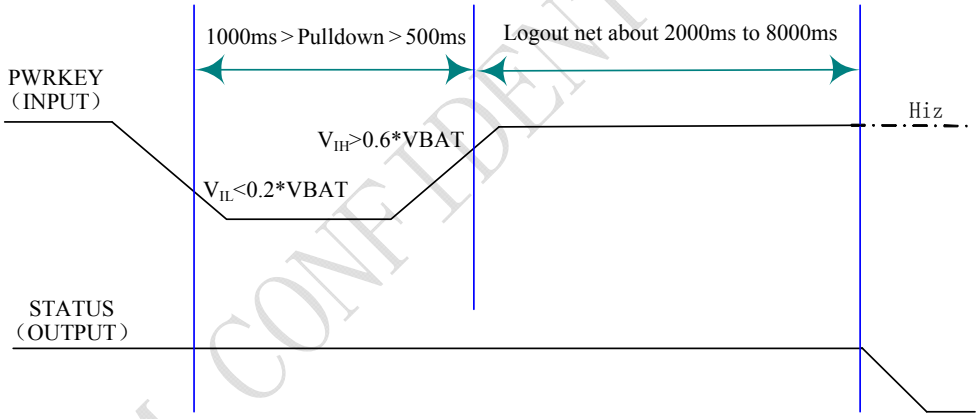

Figure 9: Timing of turn off system

3.4.2.2 Turn off SIM802 using AT command

You can use an AT command “AT+CPOWD=1” to turn off the module. This command will make the module log off from the network and allow the software to enter into a secure state and save data before completely disconnecting the power supply.

Before the completion of the switching off procedure the module will send out result code:

NORMAL POWER DOWN

After this moment, any AT commands can not be executed. Module enters into the POWER DOWN mode, only the RTC is still active. POWER DOWN can also be indicated by STATUS Pin, which is a low level voltage in this mode.

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Please refer to *document [1]* for detail about the AT command of "AT+CPOWD".

3.4.2.3 Over-voltage or under-voltage automatic shutdown

The module will constantly monitor the voltage applied on the VBAT. If the voltage ≤ 3.5V, the following URC will be presented:

UNDER-VOLTAGE WARNNING

If the voltage ≥ 4.5V, the following URC will be presented:

OVER-VOLTAGE WARNNING

The uncritical voltage range is 3.4V to 4.6V. If the voltage ≥ 4.6V or ≤ 3.4V, the module will be automatic shutdown soon.

If the voltage ≤ 3.4V, the following URC will be presented:

UNDER-VOLTAGE POWER DOWN

If the voltage ≥ 4.6V, the following URC will be presented:

OVER-VOLTAGE POWER DOWN

After this moment, no further more AT commands can be executed. The module logs off from network and enters POWER DOWN mode, and only the RTC is still active. POWER DOWN can also be indicated by STATUS Pin, which is a low level voltage in this mode.

3.4.2.4 Over-temperature or under-temperature automatic shutdown

The module will constantly monitor the temperature of the module, if the temperature ≥ 85℃, the following URC will be presented:

+CMTE:1

If the temperature ≤ -40℃, the following URC will be presented:

+CMTE:-1

The uncritical temperature range is -45℃ to 90℃. If the temperature ≥ 90℃ or ≤ -45℃, the module will be automatic shutdown soon.

If the temperature ≥ 90℃, the following URC will be presented:

+CMTE:2

If the temperature ≤ -45℃, the following URC will be presented:

+CMTE:-2

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After this moment, the AT commands can't be executed. The module logs off from network and enters POWER DOWN mode, and only the RTC is still active. POWER DOWN can also be indicated by STATUS Pin, which is a low level voltage in this mode.

To monitor the temperature, you can use the "AT+CMTE" command to read the temperature when the module is power on.

For details please refer to document [1]

You can restart SIM802 by driving the PWRKEY to a low level voltage for a period time, the same as turning on SIM802 using the PWRKEY Pin. Before restarting the SIM802, you need delay at least 500ms from detecting the STATUS low level on. The restarting scenarios illustrates as the following figure.

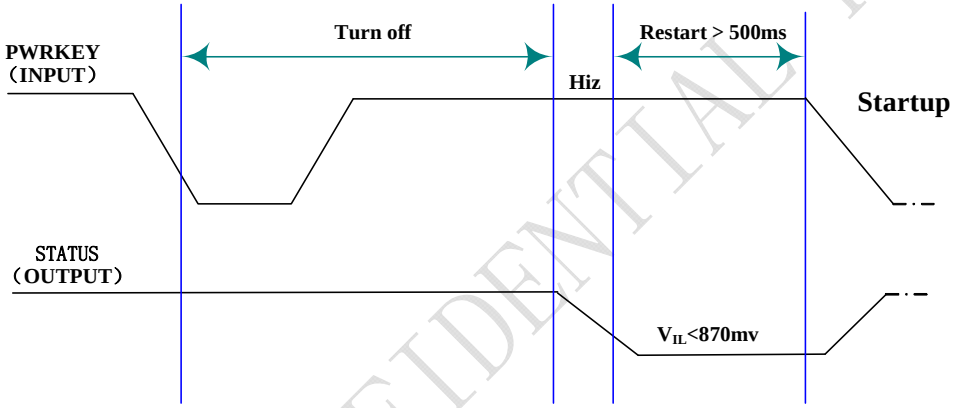

Figure 10: Timing of restart system

3.5 Charging interface

SIM802 has integrated a charging circuit inside the module for Li-Ion batteries charging control, which make it very convenient for applications to manage their battery charging. A common connection is shown in the following figure:

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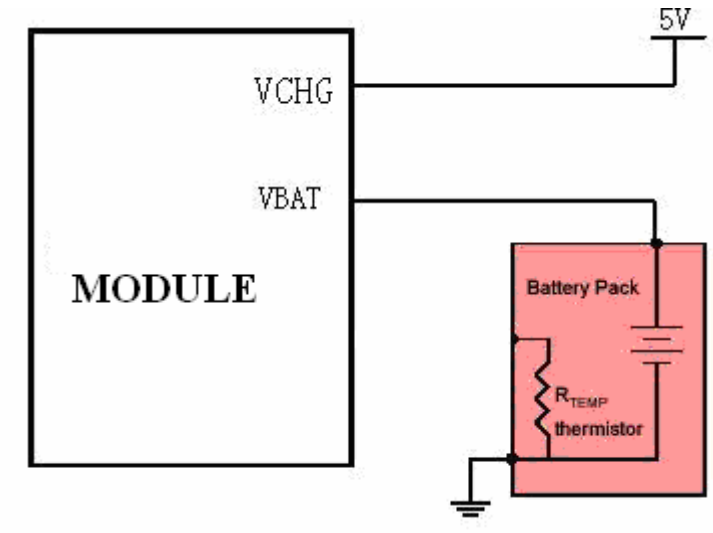

Figure 11: Battery charger and pack

The function of detecting the temperature of battery should be supported by the software in the module. It's a customization function. The R_{TEMP} is a NTC thermistor. We recommend to use NCP15XH103F03RC from MURATA. The impedance of the NTC thermistor is 10Kohm in 25℃. Please refer to the fore figure for the reference circuit.

3.5.1 Battery pack characteristics

SIM802 has optimized the charging algorithm for the Li-Ion battery that meets the characteristics listed below. To use SIM802's charging algorithm properly, it is recommended that the battery pack you integrated into your application is compliant with these specifications. The battery pack compliant with these specifications is also important for the AT command "AT+CBC" to monitor the voltage of battery, or the "AT+CBC" may return incorrect battery capacity values.

- The maximum charging voltage of the Li-Ion battery pack is 4.2V and the recommended capacity is 580mAh. If the Battery packs with a capacity more than 580 mAh, it will cost more time for charging.
- The pack should have a protection circuit to avoid overcharging, deep discharging and over-current. This circuit should be insensitive to pulsed current.
- On the SIM802, the build-in circuit of SIM802's power management chipset monitors the supply voltage constantly. Once the Under-voltage is detected, the SIM802 will be power down automatically. Under-voltage thresholds are specific to the battery pack.
- The internal resistance of the battery and the protection circuit should be as low as possible. It is recommended not to exceed 200mΩ.
- The battery pack must be protected from reverse pole connection.

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3.5.2 Recommended battery pack

Following is the spec of recommended battery pack:

Table 8: Spec of recommended battery pack

Product name & type	BYD, Li-Ion, 3.7V, 580mAh
To obtain more information Please contact :	BYD COMPANY LIMITED
Normal voltage	3.7V
Capacity	NORMAL 580mAh
Charge Voltage	4.200±0.049V
Max Charge Current	1.5C
Charge Method	CC / CV (Constant Current / Constant Voltage)
Max Discharge Current	1.5C (for continuous discharging mode)
Discharge Cut-off Voltage	2.75V/ cell
Internal resistance	Initial≤200mΩ After 400cycles ≤270mΩ

3.5.3 Implemented charging technique

The SIM802 include the function for battery charging. There are three pins in the connector related with the battery charging function: VCHG, VBAT and BAT_TEMP pins. The VCHG Pin is driven by an external voltage, system can use this Pin to detect a charger supply and provide most charging current through SIM802 module to battery when charging is in fast charge state. The VBAT give out charging current from SIM802 module to external battery. BAT_TEMP Pin is for user to measure the battery temperature. Just let this Pin open if battery temperature measuring is not your concern.

So it is very simple to implement charging technique, you need connect the charger to the VCHG Pin and connect the battery to the VBAT Pin.
The SIM802 detect charger supply and the battery is present, battery charging will happen. If there is no charger supply or no battery present the charging will not be enabled.

Normally, there are three main states in whole charging procedure.

- DDLO charge and UVLO charge;
- Fast charge;
- Trickle charge;

DDLO charge and UVLO charge:
DDLO (deep discharge lock out) is the state of battery when its voltage is under 2.4V. And

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UVLO (under voltage lock out) means the battery voltage less than 3.2V and more than 2.4V. The battery is not suitable for fast charge when its condition is DDLO or UVLO. The SIM802 provides a small constant current to the battery when the battery is between DDLO and UVLO. In DDLO charge, SIM802 gives out 5mA current to the battery. And in UVLO charge, SIM802 provides about 25mA current to the battery.

DDLO charge terminated when the battery voltage reaches 2.4V. UVLO charge terminated when the battery voltage is up to 3.2V. Both DDLO and UVLO charge are controlled by the SIM802 hardware only.

Fast charge:
If there is a charger supply and battery present and the battery is not in DDLO and UVLO, SIM802 will enter fast charge state. Fast charge is controlled by the software. Fast charge delivers a strong and constant current (about 550mA) through VBAT Pin to the battery until battery voltage reach 4.2V.

Trickle charge:
After fast charging, the battery voltage is close to the whole battery capacity, trickle charge begins. In this state, the SIM802 charges the battery under constant voltage.

3.5.4 Operating modes during charging

The battery can be charged during various operating mode. That means that when the GSM engine is in Normal mode (SLEEP, IDLE, TALK, GPRS IDLE or GPRS DATA mode), charging can be in progress while SIM802 remains operational (In this case the voltage supply should be sufficient). Here we name Charging in Normal mode as Charge mode.
If the charger is connected to the module's VCHG Pin and the battery is connected to the VBAT Pin while SIM802 is in POWER DOWN mode, SIM802 will go into the GHOST mode (Off and charging). The following table gives the difference between Charge mode and GHOST mode：

Table 9: operating modes

	How to activate mode	Features
Charge Mode	Connect charger to module's VCHG Pin and connect battery to VBAT Pin of module while SIM802 is in Normal operating mode, including: IDLE, TALK mode; SLEEP mode etc;	● GSM remains operational and registered GSM network while charging is in progress; ● The serial interfaces are available in IDLE, TALK mode, the AT command set can be used fully in this case; In SLEEP mode, the serial interfaces are not available, once the serial port is connected and there is data in transfer. Then SIM802 will exit the SLEEP mode.

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GHOST Mode	Connect charger to module's VCHG Pin while SIM802 is in POWER DOWN mode. IMPORTANT: Here GHOST mode is OFF and Charging mode, it means that not all software tasks are running.	● Battery can be charged when GSM engine is not registered to GSM network; ● Only a few AT commands is available as listed below.

Note:

VBAT can not provide much more than 5mA current while SIM802 module is during the DDLO charge state. In other words it is strongly recommended that VBAT should not be the main power supply in the application subsystem while SIM802 module is during the DDLO charge state.

Table 10: AT Command usually used in GHOST mode

AT command	Function
AT+CALARM	Set alarm time
AT+CCLK	Set data and time of RTC
AT+CPOWD	Power down
AT+CBC	Indicated charge state and voltage
AT+CFUN	Start or close the protocol Set AT command**" AT+CFUN =1**",module can be transferred from **GHOST** mode to **Charging in normal** mode, In **GHOST** mode , the default value is 0

3.5.5 Charger requirements

Following is the requirements of charger for SIM802.

- Simple transformer power plug
- Output voltage: 5.0V-5.25V
- Charging current limitation: 650mA
- A 10V peak voltage is allowed for maximum 1ms when charging current is switched off.
- A 1.6A peak current is allowed for maximum 1ms when charging current is switched on.

3.6 Power saving

There are two methods for the module to enter into low current consumption status. "AT+CFUN=0" is used to set module into minimum functionality mode and DTR hardware

interface signal can be used to lead system to be SLEEP mode (or Slow clocking mode).

3.6.1 Minimum functionality mode

Minimum functionality mode reduces the functionality of the module to a minimum and, thus, minimizes the current consumption to the lowest level. This mode is set with the "AT+CFUN" command which provides the choice of the functionality levels <fun>=0，1，4

- 0: minimum functionality;
- 1: full functionality (Default);
- 4: disable phone both transmit and receive RF circuits;

If SIM802 has been set to minimum functionality by "AT+CFUN=0", then the RF function and SIM card function will be closed. In this case, the serial port is still accessible, but all AT commands need RF function or SIM card function will not be accessible.
If SIM802 has been set by "AT+CFUN=4", then RF function will be closed. In this case, the serial ports is still active, but all AT commands need RF function will not be accessible.

After SIM802 has been set by "AT+CFUN=0" or "AT+CFUN=4", it can return to full functionality by "AT+CFUN=1".

For detailed information about "AT+CFUN", please refer to *document [1]*.

3.6.2 GSM Sleep mode (slow clocking mode)

The SIM802 can be control module to enter or exit the SLEEP mode through DTR signal. The DTR pin is pulled up to high level by a 10K resistor inside of SIM802 in order to make sure the module can enter SLEEP mode.

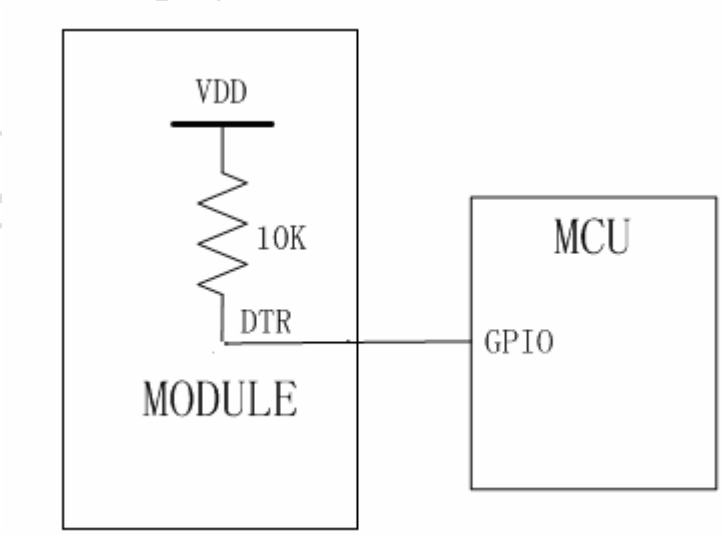

Figure 12: Typical connection of DTR

When DTR is in high level, and there is no on air and audio activity is required and no hardware interrupt (such as GPIO interrupt or data on serial port), SIM802 will enter SLEEP mode automatically. In this mode, SIM802 can still receive paging or SMS from network.

In SLEEP mode, the serial port is not accessible.

Note: For some special soft versions, it requests to set AT command "AT+CSCLK=1" to enable the sleep mode; the default value is 0, that can't make the module enter sleep mode. For more details please refer to the AT command list.

3.6.3 SRD sleep mode (slow clocking mode)

The SRD sleep mode is reserved.

3.6.4 Wake up SIM802 from GSM sleep mode

When SIM802 GSM part is in sleep mode, the following methods can wake up the module.

- Enable DTR Pin to wake up SIM802
  If DTR Pin is pull down to a low level，this signal will wake up SIM802 from power saving mode. The serial port will be active after DTR changed to low level for about 40mS.
- Receiving a voice or data call from network to wake up SIM802
- Receiving a SMS from network to wake up SIM802
- RTC alarm expired to wake up SIM802

Note: DTR Pin should be held low level during communicating between the module and DTE.

3.7 Summary of state transitions (except sleep mode)

Table 11: Summary of state transitions

Further mode / Current mode	Power down mode	Normal mode	Ghost mode (Charge-only mode)	Charging in normal mode	Alarm mode
Power down mode		Use PWRKEY	Connect charger to VCHG and connect battery to VBAT	No direct transition, but via "Ghost mode" or "Normal mode"	Switch on from POWER DOWN mode by RTC
Normal mode	AT+CPOWD or use PWRKEY Pin		Connect charger to VCHG and connect battery to VBAT, then switch off module by	Connect charger to VCHG Pin of module and connect battery to VBAT Pin of module	Set alarm by "AT+CALARM", and then switch off the module. When the

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			AT+CPOWD or using PWRKEY		timer expire, the module turn on and enter Alarm mode
Ghost mode (Charge-only mode)	Disconnect charger	No direct transition, but via “Charging in normal” mode		Turn on the module using PWRKEY OR SET AT Command “AT+CFUN=1”	Set alarm by “AT+CALARM”, when the timer expire, module will enter Alarm mode
Charging in normal mode	AT+CPOWD → “Ghost mode”, then disconnect charger	Disconnect the charger	Switch off module by AT+CPOWD or using PWRKEY		No direct transition
Alarm mode	Use PWRKEY Pin or wait module switch off automatically	Use AT+CFUN	No transition	Use AT+CFUN let module enter Normal mode, then connect the charger to VCHG Pin of module	

3.8 RTC backup

The RTC (Real Time Clock) power supply of module can be provided by an external battery or a battery (rechargeable or non-chargeable) through VRTC Pin. There is a 10K resistance which has been integrated in SIM802 module used for limiting current. You need only a coin-cell battery or a super-cap to VRTC Pin to backup power supply for RTC.

The following figures show various sample circuits for RTC backup.

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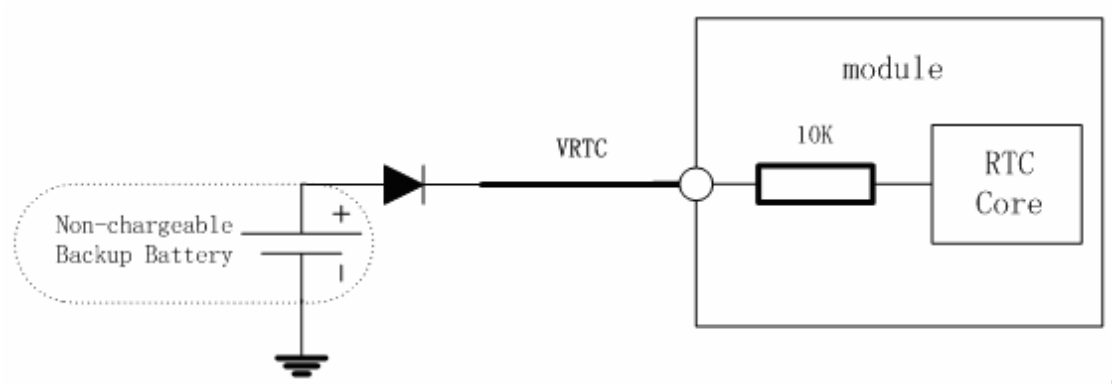

Figure 13: RTC supply from non-chargeable battery

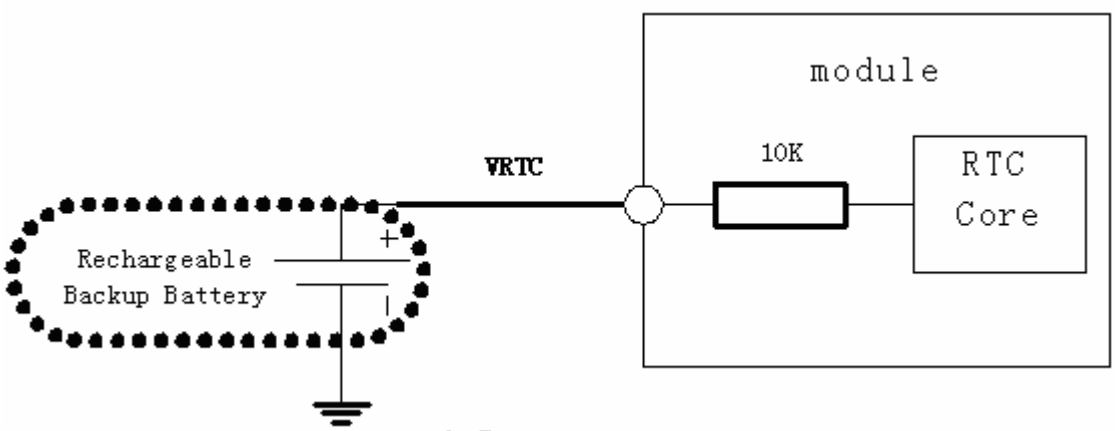

Figure 14: RTC supply from rechargeable battery

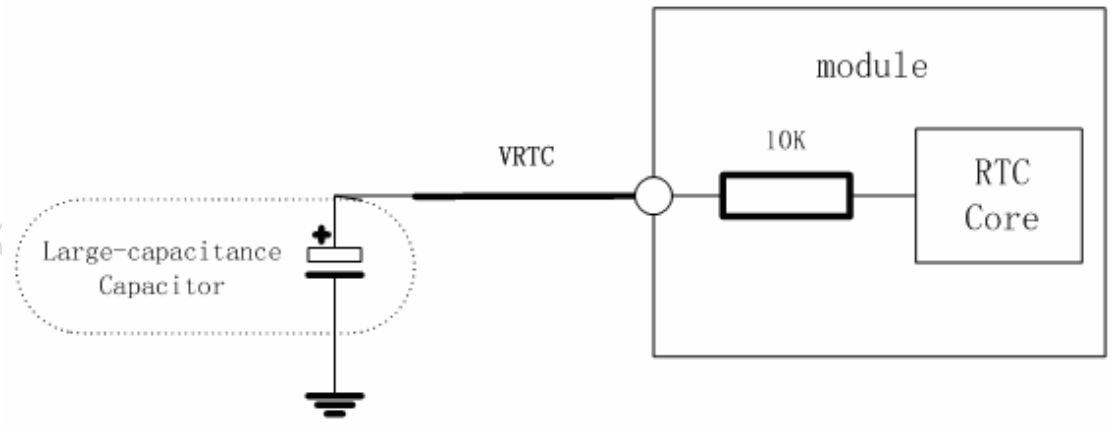

Figure 15: RTC supply from capacitor

- **Li-battery backup**

Rechargeable Lithium coin cells such as the TC614 from Maxell, or the TS621 from Seiko, are also small in size, but have higher capacity than the double layer capacitors resulting in longer backup times.

Typical charge curves for each cell type are shown in following figures. Note that the rechargeable Lithium type coin cells are generally pre-charged from the vendor.

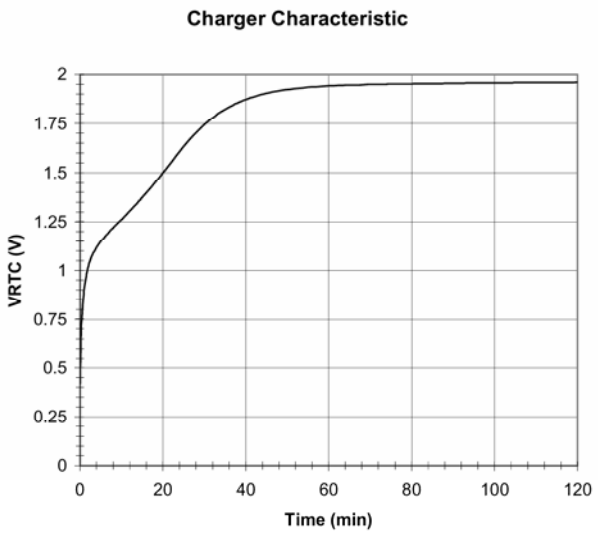

Figure 16: Panasonic EECEMOE204A Charge Characteristic

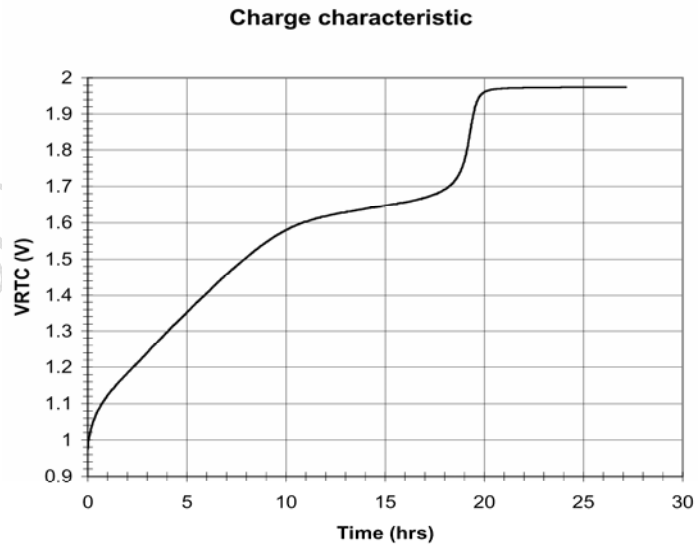

Figure 17: Maxell TC614 Charge Characteristic

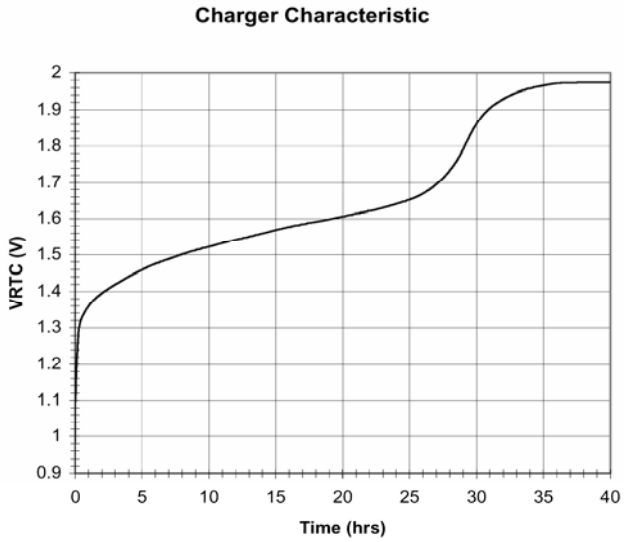

Figure 18: Seiko TS621 Charge Characteristic

- **Capacitor backup**

Some suitable coin cells are the coin-type capacitors available from SEIKO (XH414H-IV01E), or from SHOEI (PAS414HR-VG1). They have a small physical size (4.8 mm diameter) and give hours of backup time.

The specification of XH414H-IV01E is shown in following table.

Table 12: Specification of XH414H-IV01E

Parameter	Min	Type	Max	Unit
Operation temperature	-25		70	°C
Rated operation voltage		3.3		V
Charging voltage			3.3	V
Nominal capacity (discharge capacity,3.3V to 2.0V)		0.015		mAh
Nominal capacity (electrostatic capacity,3.3V to 0.0V)		0.07		F
Internal impedance		70		Ω
Nominal dimension (diameter)		4.8		mm
Nominal dimension (height)		1.4		mm

Note:

Gold-capacitance backup

Some suitable coin cells are the electric double layer capacitors available from Seiko (XC621), or from Panasonic (EECEM0E204A). They have a small physical size (6.8 mm diameter) and a nominal capacity of 0.2 F to 0.3 F, giving hours of backup time.

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3.9 Serial interfaces

SIM802 provides two unbalanced asynchronous serial ports. One is the main serial port and the other is the debug serial port. The GSM module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection. The module and the client (DTE) are connected through the following signal (as figure 19 shows). Autobauding supports bit rates from 1200 bps to 115200bps.

Main serial port

- TXD: Send data to the RXD signal line of the DTE
- RXD: Receive data from the TXD signal line of the DTE

Debug serial port

- DBG_TXD: Send data to the /RXD signal line of the DTE
- DBG_RXD: Receive data from the /TXD signal line of the DTE

NOTE: All pins of both serial ports have 8mA driver, the logic levels are described in following table

Table 13: Logic levels of serial ports pins

Parameter	Min	Max	Unit
Logic low input	0	0.87V	V
Logic high input	2.05V	3.23V	V
Logic low output	GND	0.2	V
Logic high output	2.73V	2.93V	V

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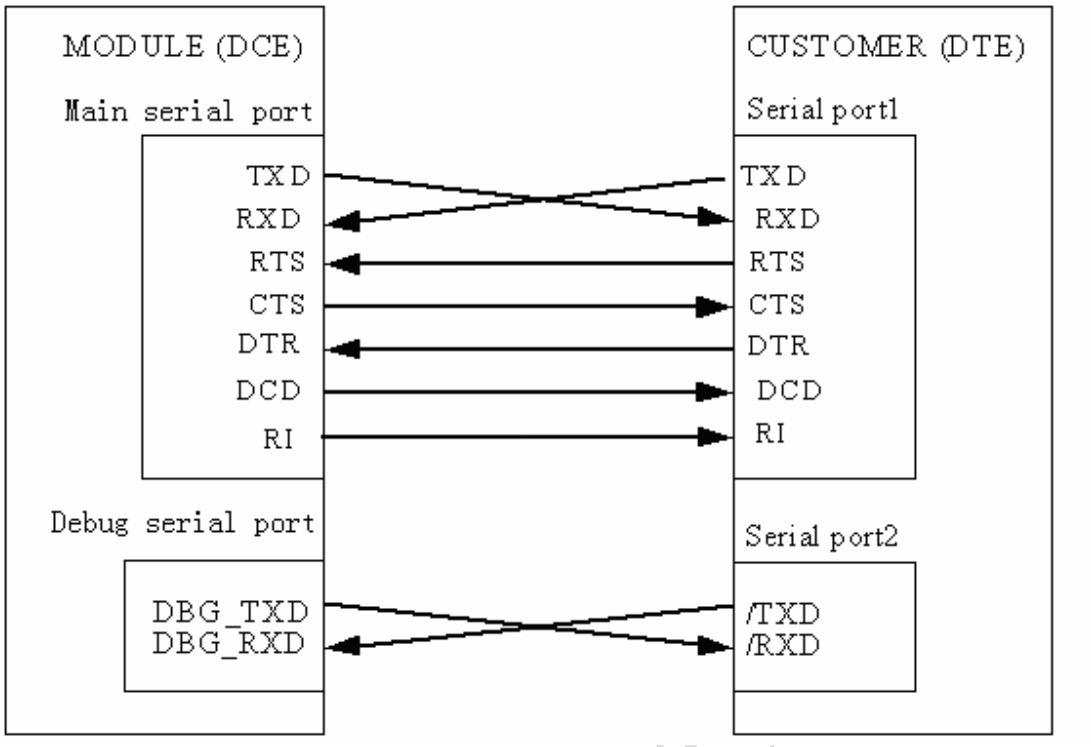

Figure 19: Connection of serial ports

Note: The RTS PIN must be connected to the GND in the customer circuit when only the TXD and RXD are used in the Serial Port communication.

3.9.1 Main serial port and Debug serial port supporting

Main serial port

- Seven lines on Serial Port Interface
- Contains Data lines TXD and RXD, State lines RTS and CTS, Control lines DTR, DCD and RING;
- Serial port can be used for CSD FAX, GPRS service and send AT command of controlling module. Also serial port can be used for multiplexing function. SIM802 supports only basic mode of multiplexing so far.
- Serial Port supports the communication rate as following:
  300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Default as 115200bps.
- Autobauding supports baud rates as following:
  4800, 9600, 19200, 38400, 57600 and 115200bps

Debug serial port

- Two lines on Serial Port Interface
- Only contains Data lines /TXD and /RXD
- Debug Port only used for debugging. It cannot be used for CSD call, FAX call. And the Debug port can not use multiplexing function;
- Debug port supports the communication rate as following:

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9600, 19200, 38400, 57600, 115200bps

Note: You can use software to set a fixed baud rate and save the configuration to non-volatile flash memory. After the configuration was saved as fixed baud rate, the Unsolicited Result Codes like "RDY" should be received from the serial port all the time when the SIM802 was power on.

3.9.2 GSM part software upgrade and software debug

The TXD、RXD、DBG_TXD、DBG_RXD、GND must be connected to the IO connector when user need to upgrade software and debug software, the TXD、RXD should be used for software upgrade and the DBG_TXD、DBG_RXD for software debugging. The PWRKEY Pin is recommended to connect to the IO connector. The user also can add a switch between the PWRKEY and the GND. The PWRKEY should be connected to the GND when SIM802 is upgrading software. Please refer to the following figure.

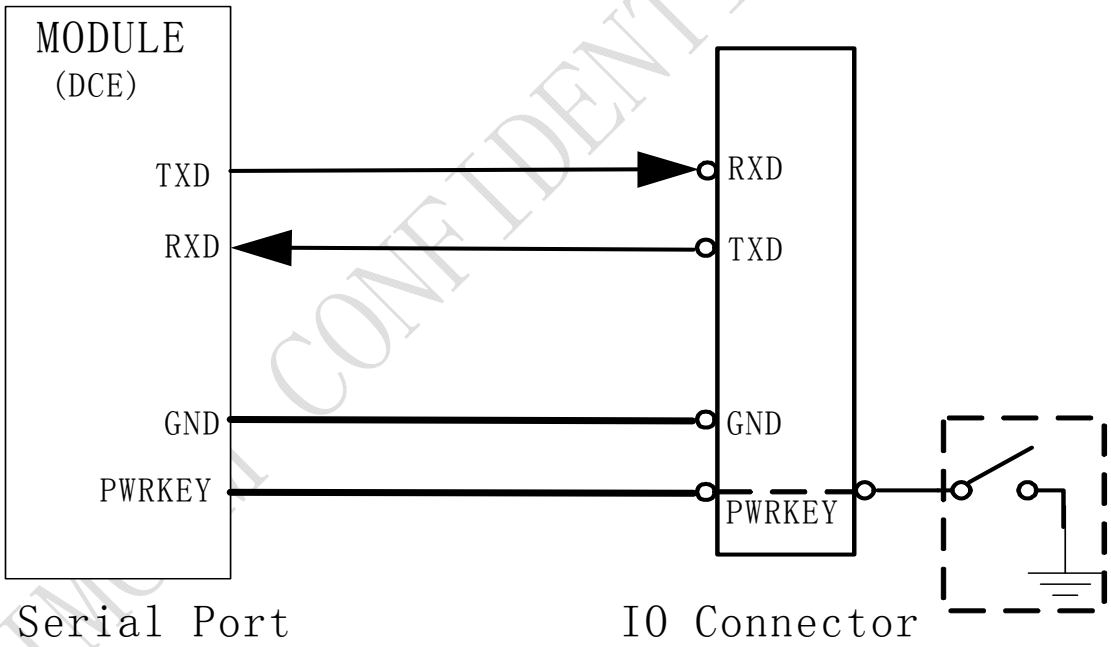

Figure 20: Connection of software upgrade

Note: The RTS PIN must be connected to the GND in the customer circuit when only the TXD and RXD used in the Serial Port communication.

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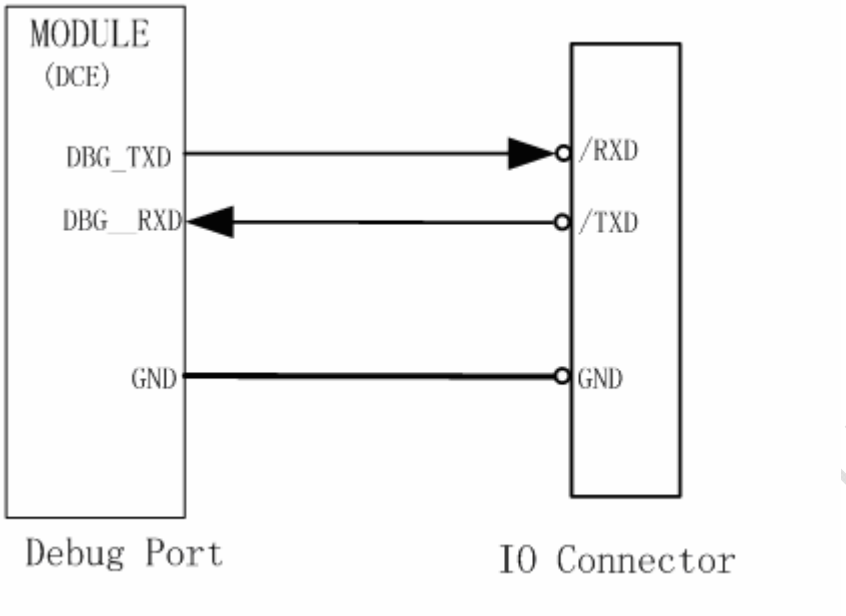

Figure 21: Connection of software debug

The main serial port and the debug serial port don't support the RS_ level and it only supports the CMOS level. Please refer to the table 5 for details about the voltage level. You should add the level converter IC between the DCE and DTE. If you connect it to the computer, please refer to the following figure.

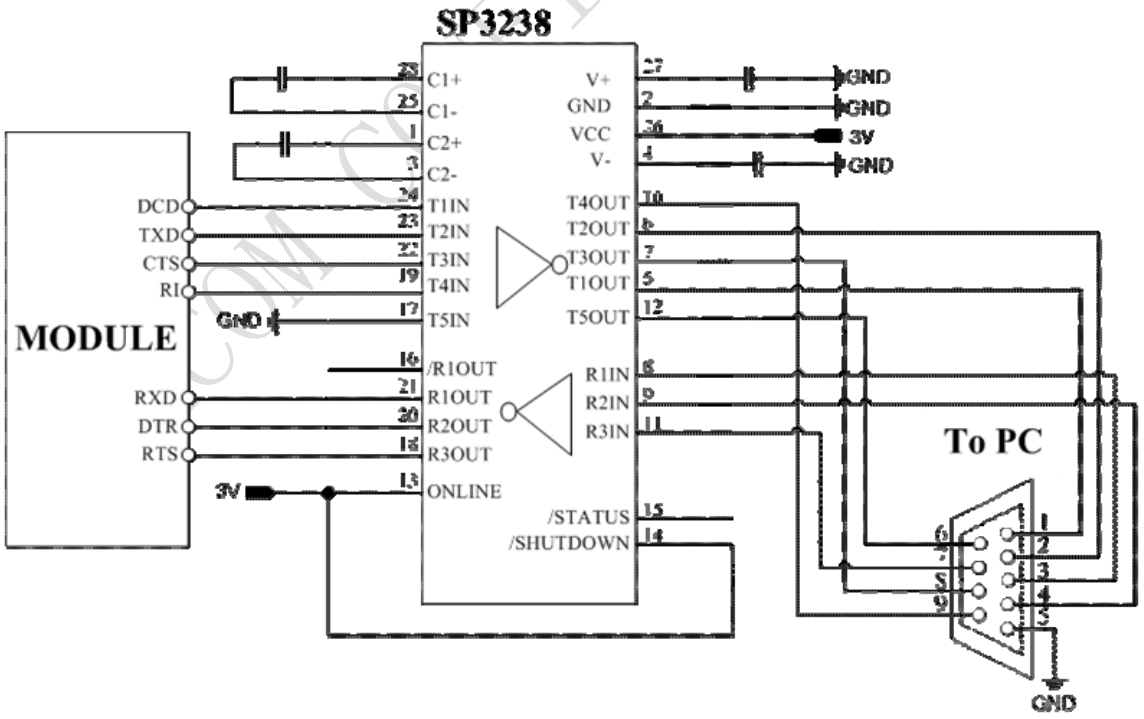

Figure 22: RS232 level converter circuit

Note：For detail information about serial port application, please refer to the document [10]

3.10 Audio interfaces

Table 14: Audio interface signal

	Name	Pin	Function
(AIN1/AOUT1)	MIC1P	21	Microphone1 input +
	MIC1N	20	Microphone1 input -
	SPK1P	23	Audio1 output+
	SPK1N	24	Audio1 output-
(AIN2/AOUT2)	MIC2P	18	Microphone2 input +
	MIC2N	19	Microphone2 input -
	SPK2P	26	Audio2 output+
	SPK2N	25	Audio2 output-

The module provides two analogy input channels, AIN1 and AIN2, which may be used for both microphone and line inputs. The AIN1 and AIN2 channels are identical. One of the two channels is typically used with a microphone built into a handset. The other channel is typically used with an external microphone or external line input. The module analogy input configuration is determined by control register settings and established using analogy multiplexers.

For each channels, you can use AT+CMIC to adjust the input gain level of microphone, use AT+SIDET to set the side-tone level. In addition, you can also use AT+CLVL to adjust the output gain level of both receiver and speaker at the same time, use AT+CHFA to activate one of the two audio channels and deactivate the other one. For more details, please refer to *document [1]*.

Note: Use AT command AT+CHFA to select audio channel:
0— AIN1/AOUT1 (normal audio channel), the default value is 0.
1— AIN2/AOUT2(aux_audio channel) .

It is suggested that you adopt one of the following two matching circuits in order to improve audio performance. The difference audio signals have to be layout according to difference signal layout rules. As show in following figures ***(Note: all components package are 0603.)*** If you want to adopt an amplifier circuit for audio, we recommend National Company's LM4890. Of course you can select it according to your requirement.

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3.10.1 Speaker interface configuration

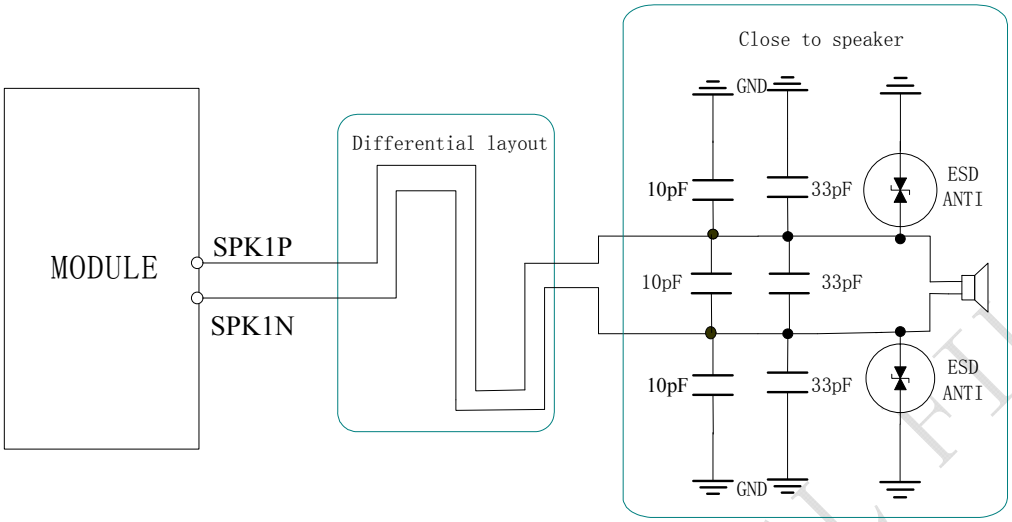

Figure 23: Speaker interface configuration

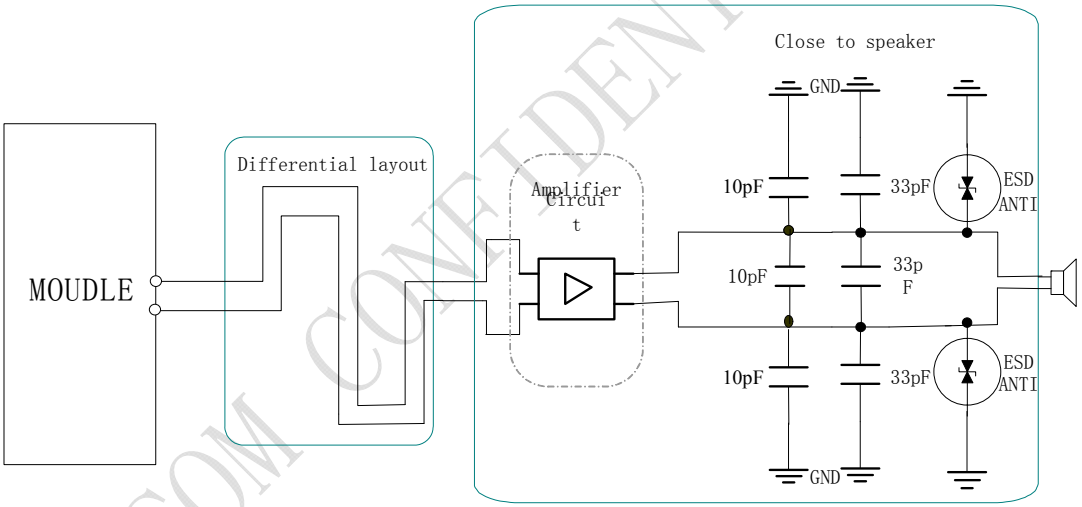

Figure 24: Speaker interface with amplifier configuration

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3.10.2 Microphone interfaces configuration

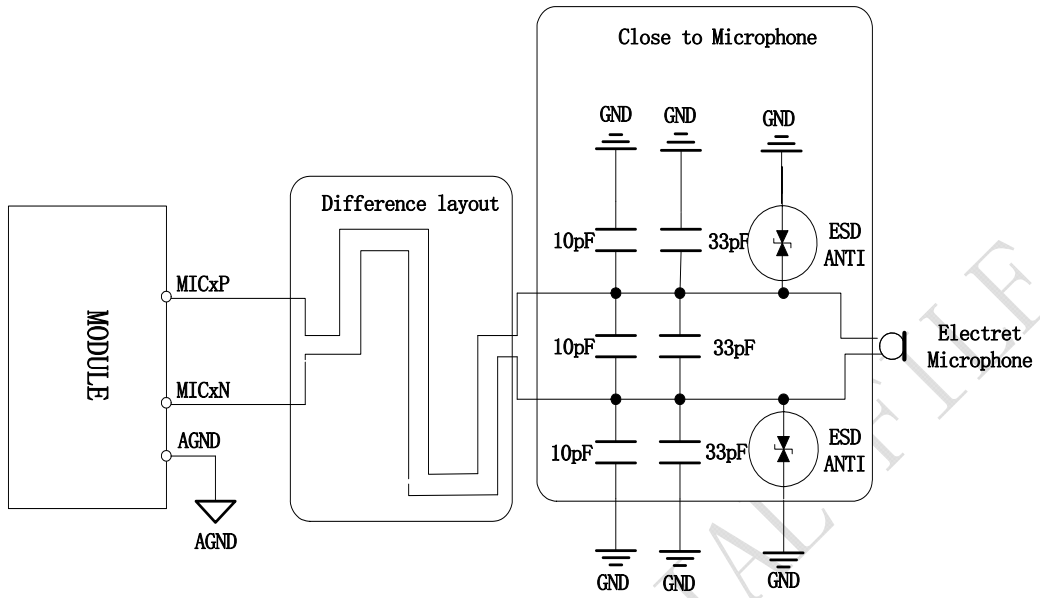

Figure 25: Microphone interface configuration

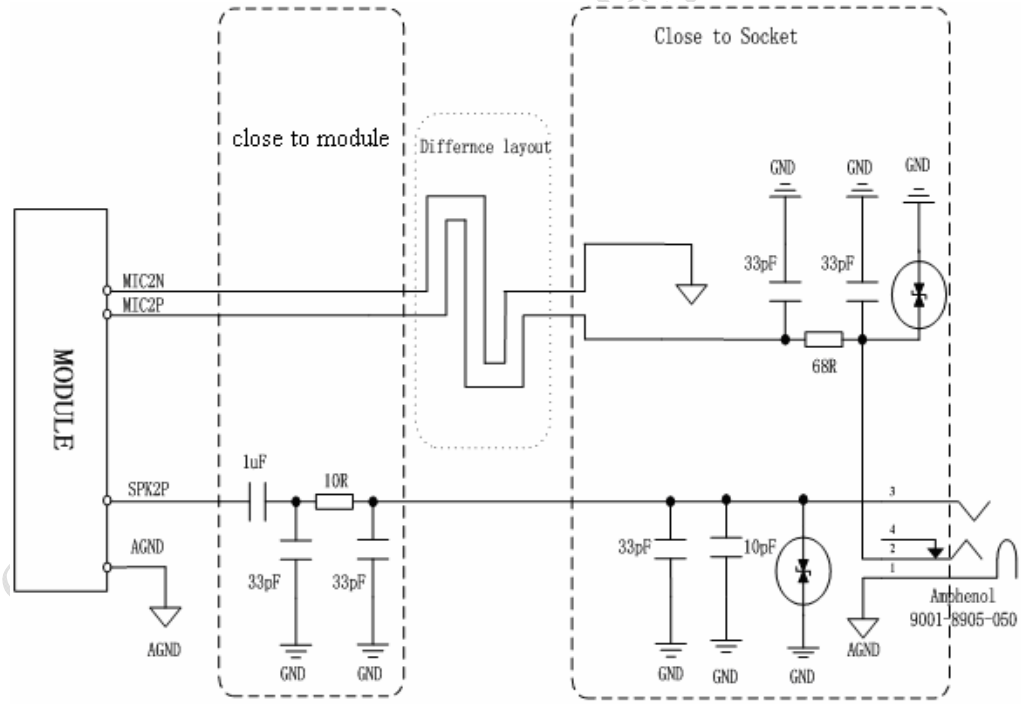

Figure 26: Earphone interface configuration

3.10.3 Referenced electronic characteristic

Table 15: MIC Input Characteristics

Parameter	Min	Typ	Max	Unit
Working Voltage	1.2	1.5	2.0	V
Working Current	300		500	uA
External Microphone Load Resistance	1.2	2.2		k Ohms

Table 16: Audio Output Characteristics

Parameter			Min	Typ	Max	Unit
Normal Output(SPK1)	Single Ended	load Resistance	27	32		Ohm
		Ref level		0.5477 -12.04		Vpp dBm
	Differential	load Resistance	27	32		Ohm
		Ref level		1.0954 -6.02		Vpp dBm
Auxiliary Output(SPK2)	Single Ended	load Resistance	27	32		Ohm
		Ref level		0.5477 -12.04		Vpp dBm
	Differential	load Resistance	27	32		Ohm
		Ref level		1.0954 -6.02		Vpp dBm

3.11 SIM interface

3.11.1 SIM card application

You can use AT Command to get information in SIM card. For more information, please refer to *document [1]*.

The SIM interface supports the functionality of the GSM Phase 1 specification and also supports the functionality of the new GSM Phase 2+ specification for FAST 64 kbps SIM (intended for use with a SIM application Tool-kit).

Both 1.8V and 3.0V SIM Cards are supported.

The SIM interface is powered from an internal regulator in the module having normal voltage 3V. All pins reset as outputs driving low. Logic levels are as described in table

Table 17: Signal of SIM interface

Signal	Pin	Description
SIM_VDD	9	SIM Card Power supply, it can identify automatically the SIM Card power mode， one is 3.0V±10%, another is 1.8V±10%. Current is about 10mA.
SIM_DATA	6	SIM Card data I/O
SIM_CLK	7	SIM Card Clock
SIM_RST	8	SIM Card Reset，it’s best to connect PF cap to GND for ESD.

Notes: The SIM802 module default supports SIM card interfaces, but the SIM802 module supports embedded SIM IC also, if the module has embedded SIM IC, SIM card interfaces keep pins open.

Following is the reference circuit about SIM interface. We recommend an Electro-Static discharge device ST (www.st.com) ESDA6V1W5 or ON SEMI (www.onsemi.com) SMF05C for “ESD ANTI”. The 22Ω resistors showed in the following figure should be added in series on the IO line between the module and the SIM card for protecting the SIM I/O port. The pull up resistor (about 10KΩ) must be added on the SIM_DATA line. Note that the SIM peripheral circuit should be placed close to the SIM card socket.

3.11.2 Design considerations for SIM card holder

The reference circuit about 6 pins SIM card illustrates as following figure.

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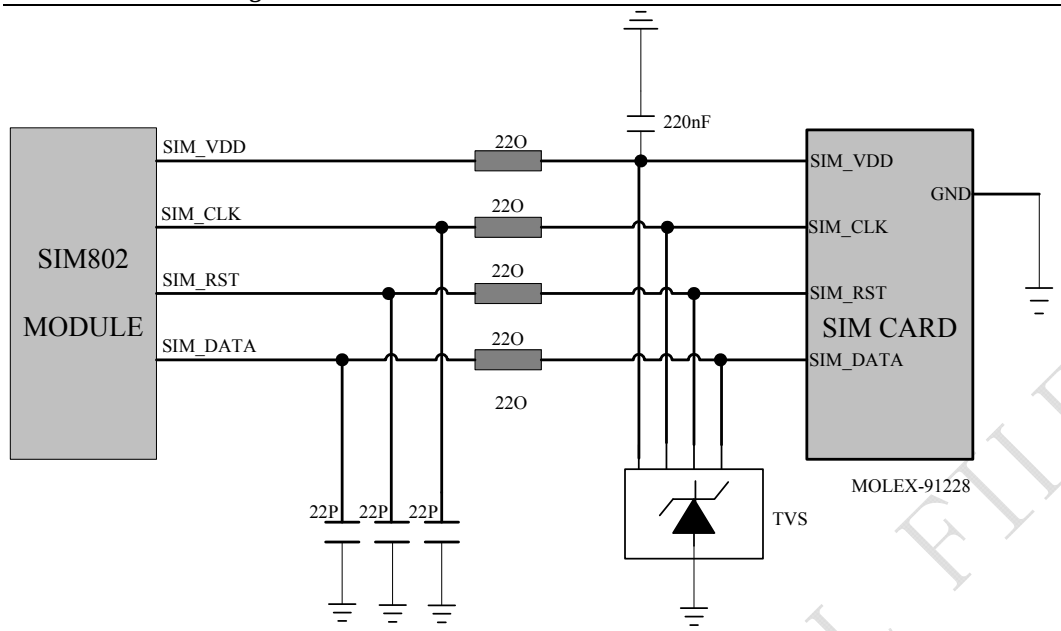

Figure 27: SIM interface reference circuit with 6 pins SIM card

3.11.3 Design considerations for SIM card holder

For 6 pins SIM card, we recommend to use Amphenol C707-10M006 512 2 .You can visit http://www.amphenol.com for more information about the holder.

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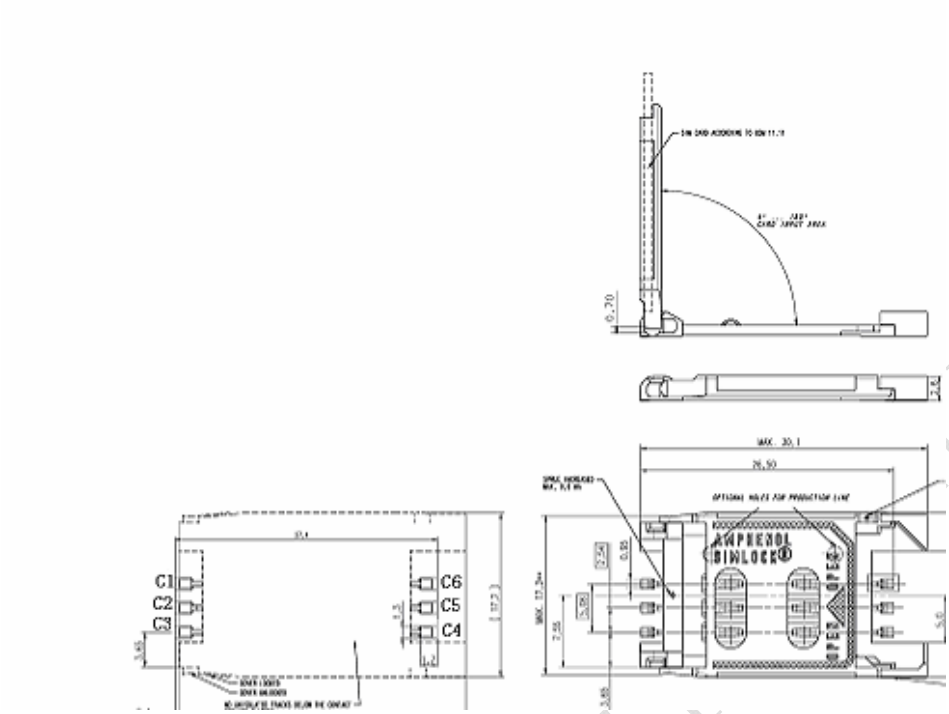

Figure 28: Amphenol C707-10M006 512 2 SIM card holder

Table 18: Pin description (Amphenol SIM card holder)

Pin	Signal	Description
C1	SIM_VDD	SIM Card Power supply, it can identify automatically the SIM Card power mode, one is 3.0V±10%, and another is 1.8V±10%. Current is about 10mA.
C2	SIM_RST	SIM Card Reset.
C3	SIM_CLK	SIM Card Clock.
C4	GND	Connect to GND.
C5	VPP	Not connect.
C6	SIM_DATA	SIM Card data I/O.

Table 19: Pin description (Molex SIM card holder)

Pin	Signal	Description
C1	SIM_VDD	SIM Card Power supply, it can identify automatically the SIM Card power mode, one is 3.0V±10%, and another is 1.8V±10%. Current is about 10mA.
C2	SIM_RST	SIM Card Reset.
C3	SIM_CLK	SIM Card Clock.

C4	SIM Card Detect	0Ω pulled up to VEXT
C5	GND	Connect to GND.
C6	VPP	Not connect.
C7	SIM_DATA	SIM Card data I/O.
C8	SIM Card Detect	10KΩ pulled down to GND

For 8 pins SIM card holder, we recommend to use Molex 91228.You can visit http://www.molex.com for more information about the holder.

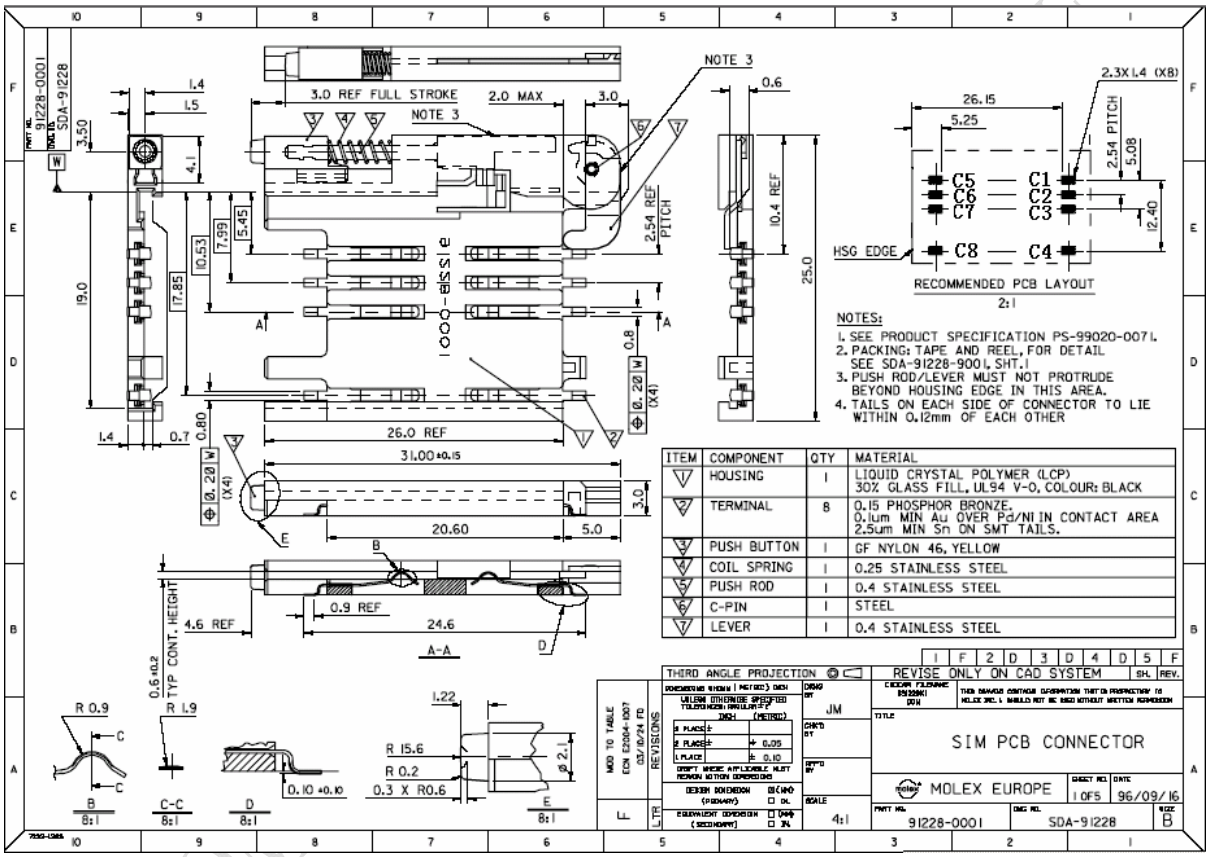
NOTES:
1. SEE PRODUCT SPECIFICATION PS-99020-0071.
2. PACKING: TAPE AND REEL, FOR DETAIL SEE SDA-91228-9001, SHT.1
3. PUSH ROD/LEVER MUST NOT PROTRUDE BEYOND HOUSING EDGE IN THIS AREA.
4. TAILS ON EACH SIDE OF CONNECTOR TO LIE WITHIN 0.12mm OF EACH OTHER
ITEM COMPONENT QTY MATERIAL
1 HOUSING 1 LIQUID CRYSTAL POLYMER (LCP) 30% GLASS FILL, UL94 V-0, COLOUR: BLACK
2 TERMINAL 8 0.15 PHOSPHOR BRONZE. 0.1um MIN Au OVER Pd/NI IN CONTACT AREA 2.5um MIN Sn ON SMT TAILS.
3 PUSH BUTTON 1 GF NYLON 46, YELLOW
4 COIL SPRING 1 0.25 STAINLESS STEEL
5 PUSH ROD 1 0.4 STAINLESS STEEL
6 C-PIN 1 STEEL
7 LEVER 1 0.4 STAINLESS STEEL
RECOMMENDED PCB LAYOUT
2:1
THIRD ANGLE PROJECTION
REVISE ONLY ON CAD SYSTEM
SIM PCB CONNECTOR
MOLEX EUROPE
91228-0001
SDA-91228

Figure 29: Molex 91228 SIM card holder

3.12 LCD display interface

SIM802 provides a serial LCD display interface. These are composite pins that can be used as GPIO ports or LCD display interface according to your application. When used as LCD interface, the following table is the pin definition. LCD interface timing should be united with the LCD device.

Table 20: PIN definition of the LCD interface

Name	Pin	Function
DISP_CS	58	Display enable
DISP_CLK	13	Display clock
DISP_DATA	14	Display data output
DISP_D/C	16	Display data or command select
DISP_RST	59	LCD reset

Note: This function is not supported in the default firmware. For more information, please contact SIMCom.

3.13 General purpose input & output (GPIO)

SIM802 provides a limited number of General Purpose Input/Output signal Pin.

Table 21: GPIO of SIM802

Name	Pin	I/O	Description
GPIO	52	I/O	General purpose Input/Output

SIM802 supports two general purpose output signal Pins. These Pins can be configured through AT command "AT+CGPIO" in users' application to high voltage level or low voltage level. For detail of this AT command, please refer to *document [1]*.

3.14 ADC

SIM802 provide one auxiliary ADC (General purpose analog to digital converter.) as voltage input Pin, which can be used to detect the values of some external items such as voltage, temperature etc. User can use AT command "AT+RADC" to read the voltage value added on ADC Pin. For detail of this AT command, please refer to *document [1]*.

Table 22: ADC specification

	Min	Type	Max	Units
Voltage range	0		2.4	V
ADC Resolution		16		bits
ADC accuracy[1]		0.59		mV
Sampling rate		3		KHz

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3.15 Behaviors of the Ring line (The main serial interface only)

Table 23: Behaviours of the Ring line

State	RI respond
Standby	HIGH
Voice calling	Change LOW, then: （1）Change to HIGH when establish calling. （2）Use AT command ATH, the RI Pin changes to HIGH. （3）Sender hangs up, change to HIGH. (4) Change to HIGH when SMS received.
Data calling	Change LOW, then： （1）Change to HIGH when establish calling. （2）Use AT command ATH, the RI changes to HIGH.
SMS	When receive SMS, The RI will change to LOW and hold low level about 120 ms, then change to HIGH.
URC	Some URCs triggers 120ms low level on RI. For more details, please refer to *document[10]*

If the module is used as caller, signal RI will maintain high. But when it is used as receiver, following is timing of RI.

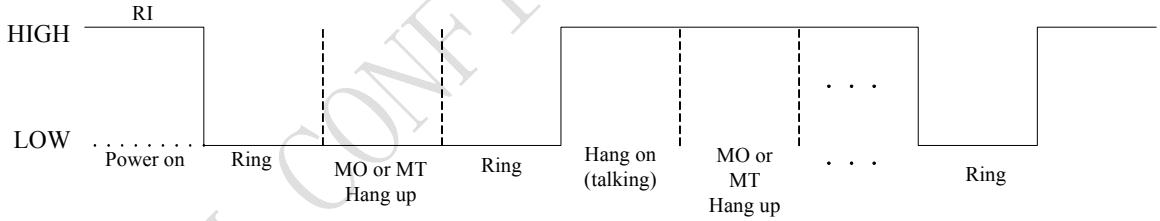

Figure 30: SIM802 Services as Receiver

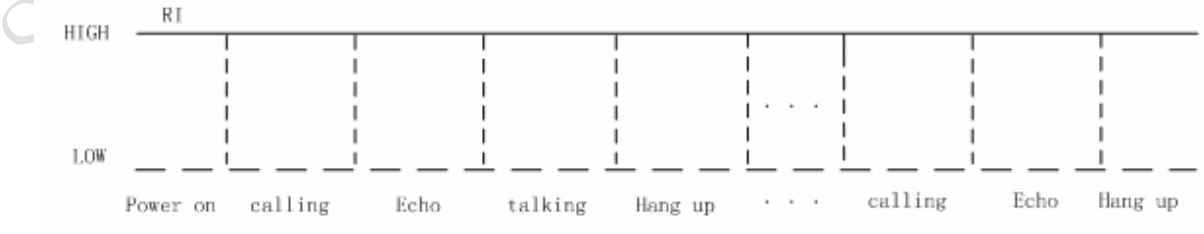

Figure 31: SIM802 Services as caller

3.16 Network status indication LED lamp

The NETLIGHT Pin can be used to drive a network status indication LED lamp. The working state of this Pin is listed in table 24:

Table 24: Working state of network status indication LED Pin

State	SIM802 function
Off	SIM802 is not running
64ms On/ 800ms	SIM802 does not find the network
64ms On/3000ms	SIM802 find the network
64ms On/ 300ms	GPRS communication

The reference circuitry for you, shown as following figure:

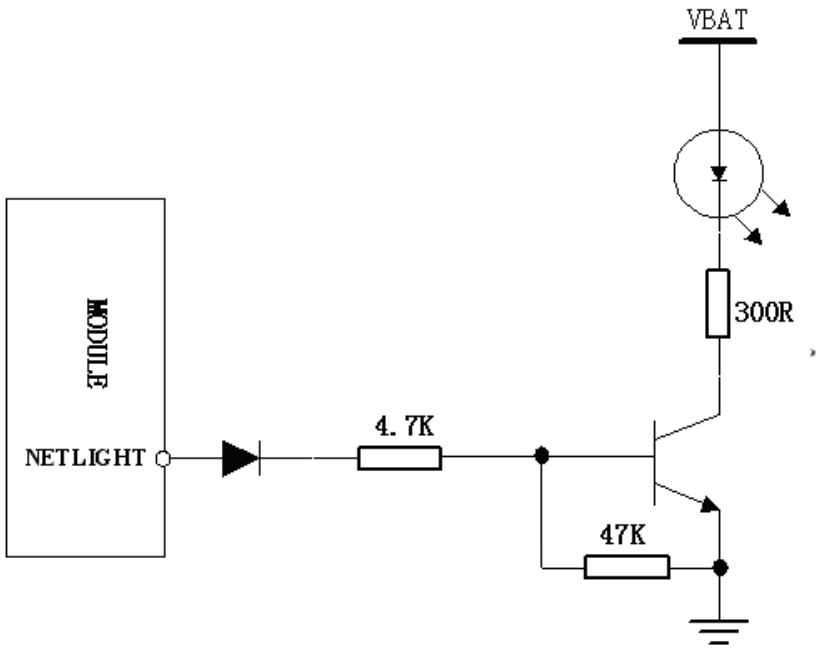

Figure 32: Reference circuit for Network status LED

3.17 SRD interface

Table 25: Pin definition of the SRD interface

Name	I/O	Typical	Alternate	Description
SCLK	I/O	GPIO	Clock of SPI	General purpose input and output
MISO	I/O	GPIO	Master in slave out of	

			SPI	
MOSI	I/O	GPIO	Master out slave in of SPI	
NSS	I/O	GPIO	Slave select input of SPI	
SCK	I/O	GPIO	I^2C clock	
SDA	I/O	GPIO	I^2C data	
C2D		Reserve		
NRST		Reserve		

The reference circuit for I^2C shown as following figure:

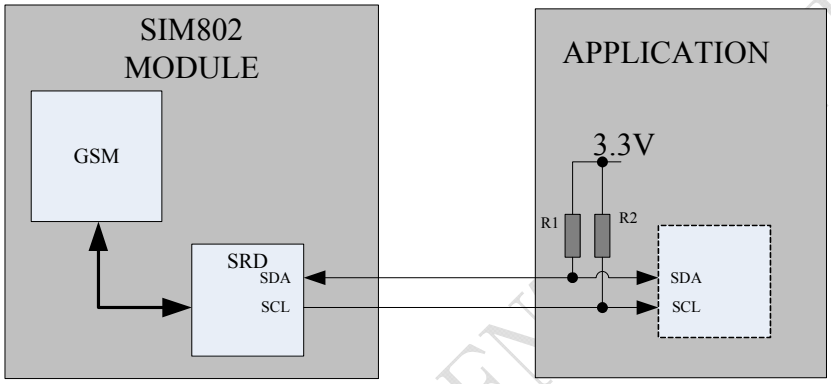

Figure 33: I^2C application of the SRD interface

In the application I^2C SDA and I^2C SCL lines need to be connected to a positive supply voltage via a pull-up resistor.

The reference circuit for SPI shown as following figure:

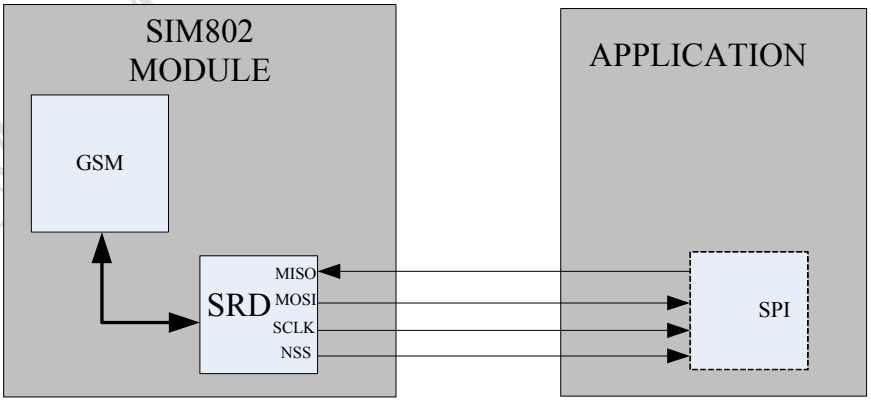

Figure 34: SPI application of the SRD interface

Note: This function is not supported in the default firmware. For more information, please contact SIMCom.

3.18 Buzzer

The buzzer can be used to drive a buzzer to indicate incoming call. The output volume of buzzer can be set by "AT+CRSL". The reference circuit for buzzer shown as following figure:

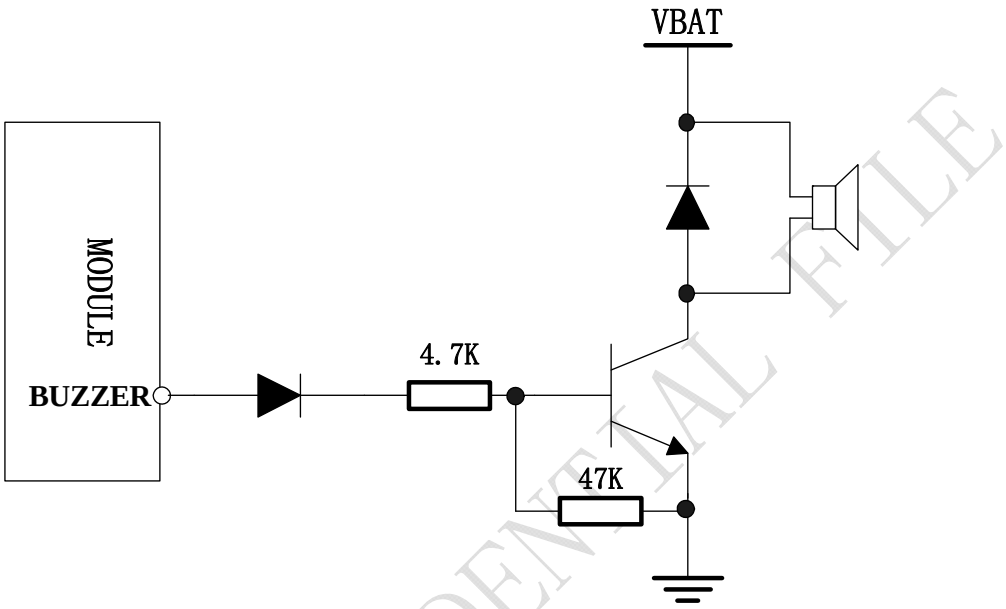

Figure 35: Reference circuit of Buzzer

Table 26: Buzzer output characteristics

Parameter	Min	Type	Max	Unit
Working Voltage	2.4	2.8	3.3	V
Working Current		2		mA
Load Resistance	1			k Ohms

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4 Antenna interface

- The Pin 45 is the GSM RF antenna pad. The RF interface has an impedance of 50Ω.
- The Pin 33 is the SRD RF antenna pad. The RF interface has an impedance of 50Ω.

4.1 Antenna installation

4.1.1 Antenna pad

SIM802 provides RF antenna interface. And customer's antenna should be located in the customer's main board and connect to module's antenna pad through microstrip line or other type RF trace which impendence must be 50Ω. To help you to ground the antenna, SIM802 comes with a grounding plane located close to the antenna pad. The antenna pad of SIM802 is shown as figure 36:

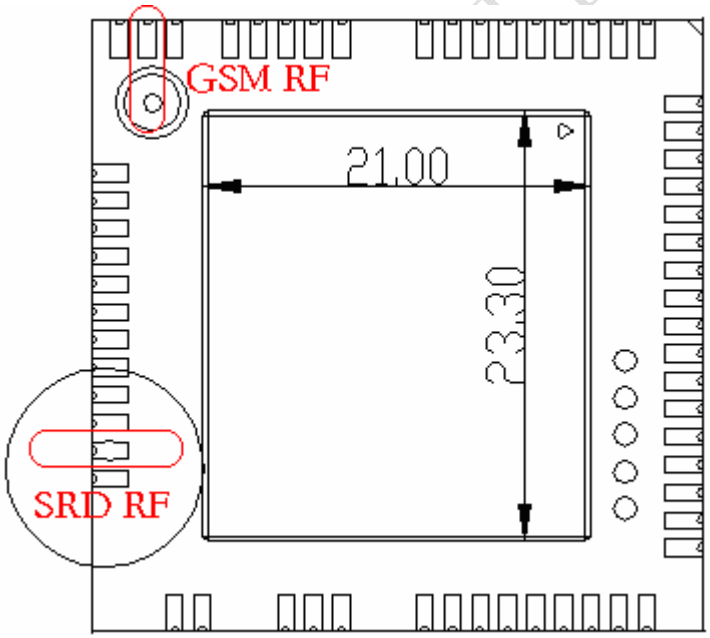

Figure 36: RF Pad (Bottom view)

NOTE：Please do reassure that there isn't any trace under GSM antenna pad and SRD antenna pad when you paste SIM802 to your main PCB. You can play traces under the pads only when there is a ground plane separated from disturbing.

SIM802 material properties:
SIM802 PCB material: FR4
Antenna pad: Gold plated pad

4.2 Module RF output power

Table 27: SIM802 conducted RF output power

Frequency	Max	Min
EGSM900	33dBm ±2db	5dBm±5db
GSM850	33dBm ±2db	5dBm±5db
DCS1800	30dBm ±2db	0dBm±5db
PCS1900	30dBm ±2db	0dBm±5db
SRD-RF	18dBm	9dBm

The SRD-RF output power can be programmed from 9dBm to 18dBm in 3dB steps. It can be easily set through AT command.

4.3 Module RF receive sensitivity

Table 28: SIM802 conducted RF receive sensitivity

Frequency	Receive sensitivity
EGSM900	< -106dBm
GSM850	< -106dBm
DCS1800	< -106dBm
PCS1900	< -106dBm
SRD-RF	<-118dBm@2400bps

4.4 Module operating frequencies

Table 29: SIM802 GSM operating frequencies

Frequency	Receive	Transmit
EGSM900	925 ～ 960MHz	880 ～ 915MHz
GSM850	869 ～ 894MHz	824 ～ 849 MHz
DCS1800	1805 ～ 1880MHz	1710 ～ 1785MHz
PCS1900	1930 ～ 1990MHz	1850 ～ 1910MHz

Table 30: SIM802 SRD operating frequencies

Module	Receive Frequency	Frequency Interval
SIM802-A	433 ～ 434.79MHz	
SIM802-B	863 ～ 870MHz	
SIM802-C	902 ～ 928MHz	

5 Electrical, reliability and radio characteristics

5.1 Absolute maximum ratings

Absolute maximum rating for power supply and voltage on digital and analog pins of SIM802 are listed in table31:

Table 31: Absolute maximum rating

Parameter	Min	Max	Unit
Peak current of power supply	0	3.0	A
RMS current of power supply (during one TDMA- frame)	0	0.7	A
Voltage at digit pins	-0.3	3.3	V
Voltage at analog pins	-0.3	3.0	V
Voltage at digit/analog pins in POWER DOWN mode	-0.25	0.25	V

5.2 Operating temperatures

The operating temperature is listed in table32:

Table 32: SIM802 operating temperature

Parameter	Min	Type	Max	Unit
Ambient temperature	-30	25	80	℃
Restricted operation*	-40 to -30		80 to 85	℃
Storage temperature	-45		90	℃

* SIM802 does work, but the deviation from the GSM specification may occur, For example, the frequency error or the phase error will be large

5.3 Power supply rating

Table 33: SIM802 power supply rating

Parameter	Description	Conditions	Min	Type	Max	Unit
VBAT	Supply voltage	Voltage must stay within the min/max values, including voltage drop, ripple, and spikes.	3.4	4.0	4.5	V
	Voltage drop during transmit burst	Normal condition, power control level for Pout max			400	mV

	Voltage ripple	Normal condition, power control level for Pout max @ f<200kHz @ f>200kHz			50 2	mV
IVBAT	Average supply current	POWER DOWN mode SLEEP mode (BS-PA-MFRMS=5)		45 2.5		uA mA
		IDLE mode GSM850/EGSM 900 DCS1800/PCS1900		 18.7 18		 mA
		TALK mode GSM850/EGSM 900 DCS1800/PCS1900		 250 184		 mA
		DATA mode GPRS, (3 Rx, 2 TX) GSM850/EGSM 900 DCS1800/PCS1900		 436 350		 mA
		DATA mode GPRS, (4 Rx, 1 TX) GSM850/EGSM 900 DCS1800/PCS1900		 245 180		 mA
	Peak supply current (during transmission slot every 4.6ms)	Power control level for Pout max.		2	3	A

5.4 Current consumption

The values for current consumption listed refer to following table.

Table 34: SIM802 current consumption

Voice Call	
GSM 850/EGSM 900	@power level #5 <350mA,Typical 240mA @power level #10,Typical 125mA @power level #19,Typical 90mA
DCS1800/PCS1900	@power level #0 <300mA,Typical 220mA @power level #10,Typical 115mA @power level #15,Typical 90mA
GPRS Data	
DATA mode, GPRS (1 Rx,1 Tx) CLASS 8	
GSM 850/EGSM 900	@power level #5 <350mA,Typical 260mA @power level #10,Typical 125mA

	@power level #19,Typical 90mA
DCS1800/PCS1900	@power level #0 <300mA,Typical 220mA @power level #10,Typical 83mA @power level #15,Typical 76mA
DATA mode, GPRS (3 Rx, 2 Tx) CLASS 10	
GSM 850/EGSM 900	@power level #5 <550mA,Typical 420mA @power level #10,Typical 225mA @power level #19,Typical 142mA
DCS1800/PCS1900	@power level #0 <450mA,Typical 380mA @power level #10,Typical 140mA @power level #15,Typical 127mA
DATA mode, GPRS (4 Rx,1 Tx) CLASS 8	
GSM 850/EGSM 900	@power level #5 <350mA,Typical 270mA @power level #10,Typical 160mA @power level #19,Typical 120mA
DCS1800/PCS1900	@power level #0 <300mA,Typical 230mA @power level #10,Typical 120mA @power level #15,Typical 113mA

Class 10 is default set when the module work at data translation mode, the module can also work at class 8 set by AT command.

5.5 Electro-Static discharge

The GSM engine is not protected against Electrostatic Discharge (ESD) in general. Therefore, it is subject to ESD handing precautions that typically apply to ESD sensitive components. Proper ESD handing and packaging procedures must be applied throughout the processing, handing and operation of any application using a SIM802 module.
The measured values of SIM802 are shown as the following table:

Table 35: The ESD endure statue measured table

The test condition: temperature 25℃, humidity 45%

Part	Contact discharge	Air discharge
VBAT,GND	±5KV	±10KV
KBR0-4, DTR, RXD, TXD, RTS, DISP_DATA, DISP_CLK	±4KV	±8KV
Antenna pad	±5KV	±10KV
Other pad	±3KV	±6KV

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6 Mechanics

This chapter describes the mechanical dimensions of SIM802.

6.1 Mechanical dimensions of SIM802

Following shows the mechanical dimensions of SIM802 (top view, side view and bottom view). All dimensions are shown in millimeters.

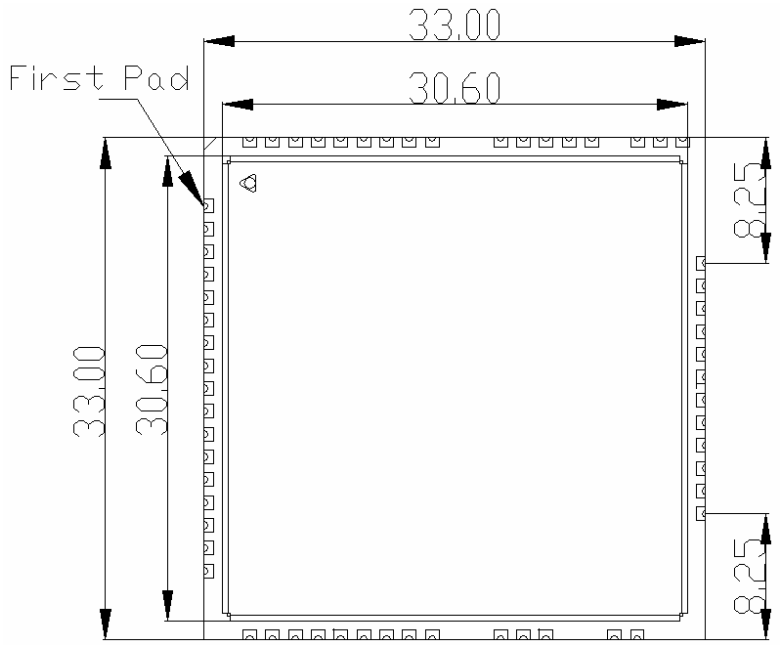

Figure 37: SIM802 top view

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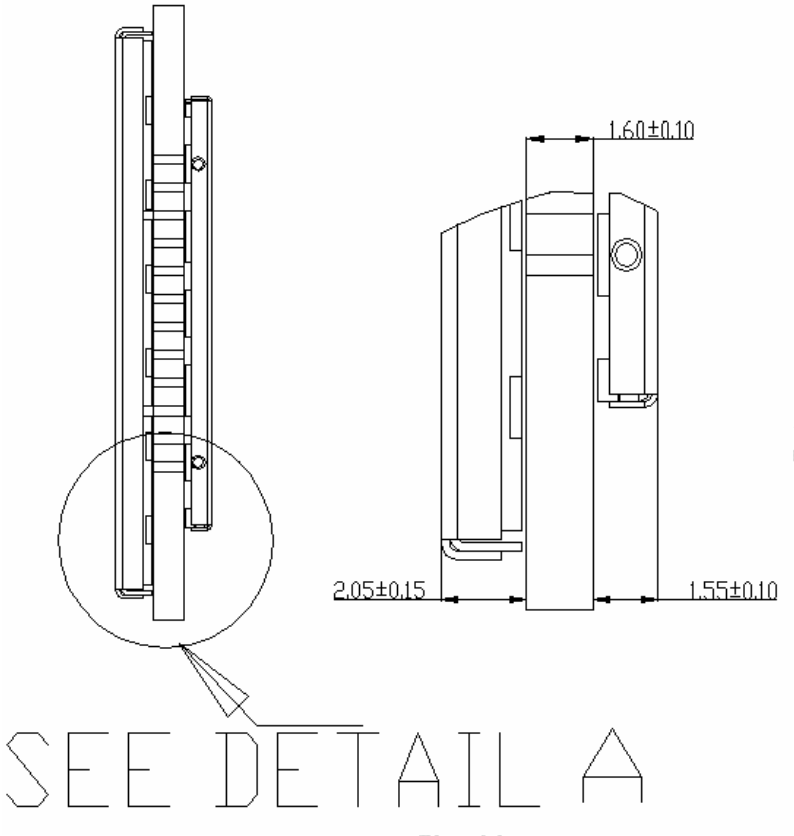

Figure 38: SIM802 side view

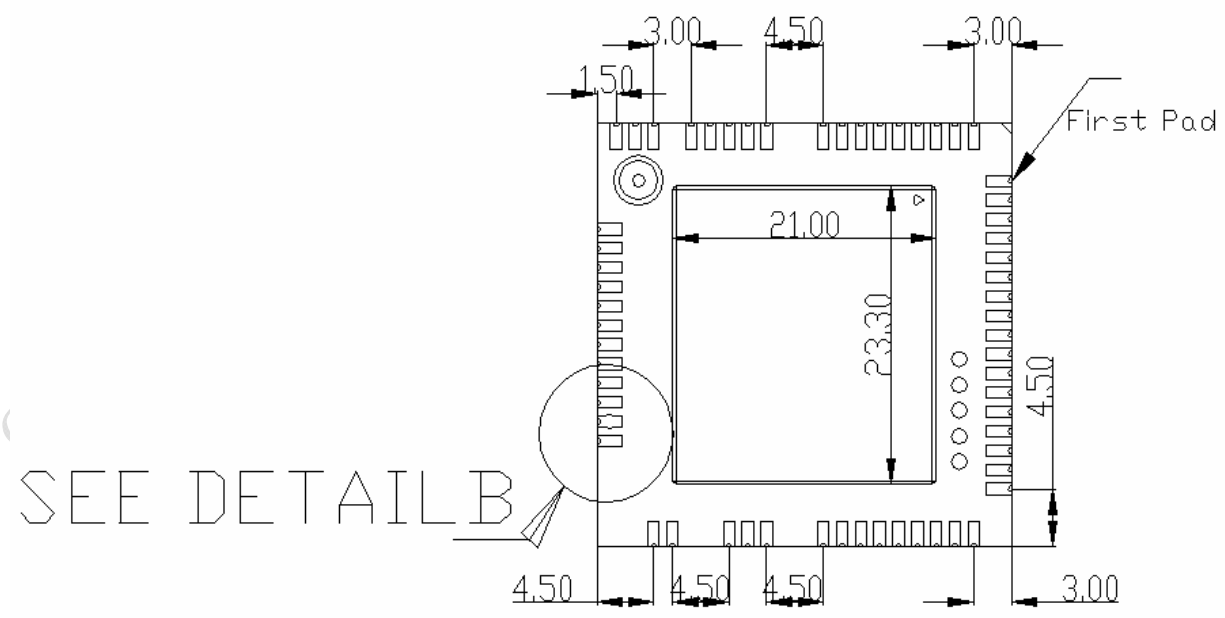

Figure 39: SIM802 bottom view

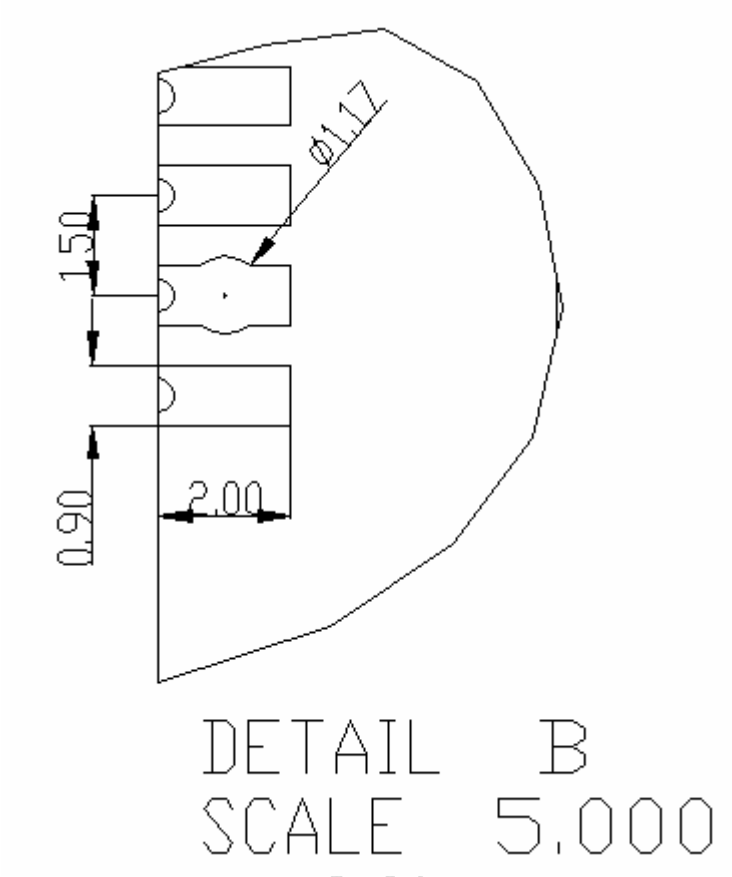

Figure 40: Pad bottom view

Following shows the footprint recommendation dimensions of SIM802.

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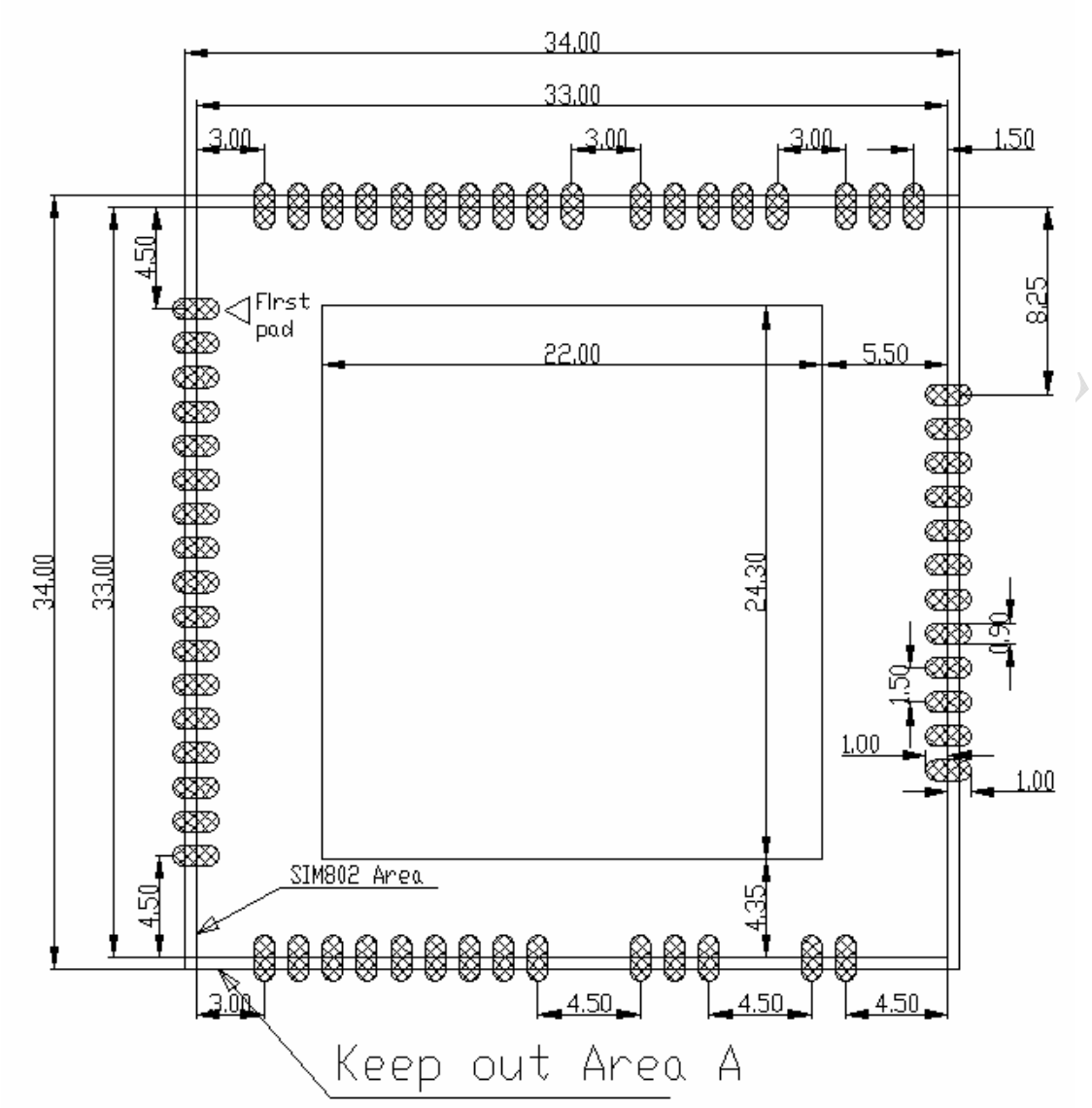

Figure 41: Footprint recommendation

Notes：

Keep out on the user mainboard below the test point and the keep out area, as these are solder mask.

For maintain this module, the placement must be keep a distance between the module and other component about 3 mm, and the height of near components must less than 16mm.

6.2 PIN assignment of SIM802

Table 36: PIN assignment

Pin No.	NAME	Pin No.	NAME
1	DBG_RXD	**31**	GND
2	DBG_TXD	**32**	GND
3	RXD	**33**	SRD_RF
4	TXD	**34**	GND
5	STATUS	**35**	GND
6	SIM_DATA	**36**	SDA
7	SIM_CLK	**37**	SCL
8	SIM_RST	**38**	SCLK
9	SIM_VDD	**39**	MISO
10	KROW0	**40**	MOSI
11	RI	**41**	NSS
12	PWRKEY	**42**	C2D
13	DISP_CLK	**43**	NRST
14	DISP_DATA	**44**	GND
15	VRTC	**45**	GSM_RF
16	DISP_D/C	**46**	GND
17	GND	**47**	GND
18	MIC2P	**48**	GND
19	MIC2N	**49**	GND
20	MIC1N	**50**	VBAT
21	MIC1P	**51**	VBAT
22	AGND	**52**	GPIO
23	SPK1P	**53**	NETLIGHT
24	SPK1N	**54**	DCD
25	SPK2N	**55**	DTR
26	SPK2P	**56**	RTS
27	TEMP_BAT	**57**	CTS
28	VCHG	**58**	DISP_CS
29	ADC0	**59**	DISP_RST
30	GND	**60**	GND

NOTE: If any Pin you would not use in your application design, it is recommended that leave the relative pad empty in your main board.

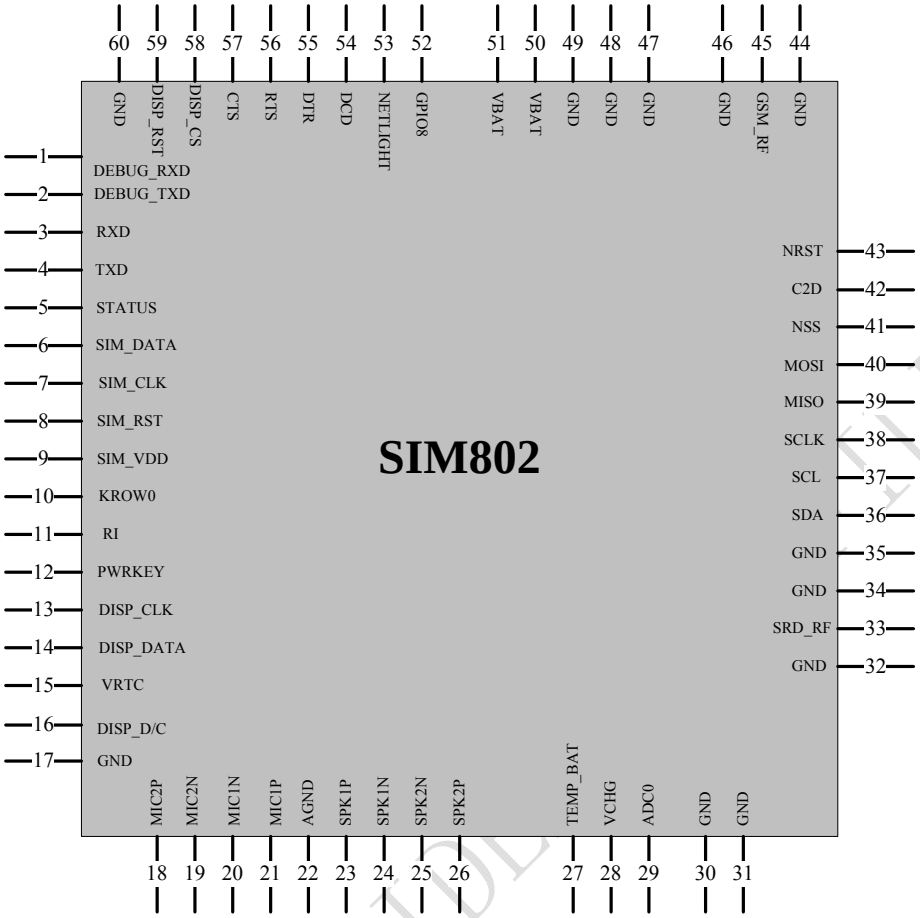

Figure 42: SIM802 pins definition (top view)

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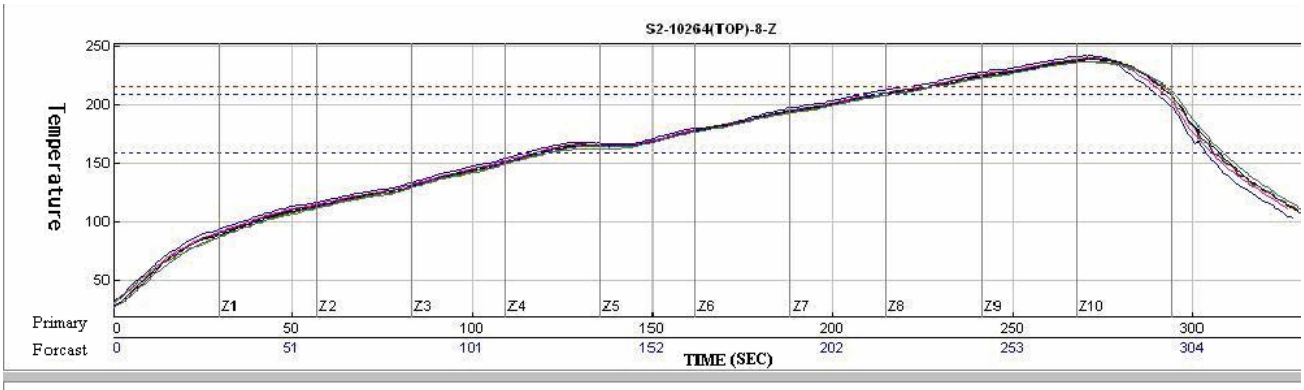
Figure 43: Bottom view of SIM802

Figure 44: Top view of SIM802

6.3 The ramp-soak-spike reflow profile of SIM802

If both sides of the mainboard have SMD parts, the SIM802 module must be soldered last.



TCs	RAMP		SOAP between 160 to 210C		REFLOW /217C		PEAK TEMPERATURE	
2	1.3	-12%	94.4	15%	63.1	-48%	241.2	12%
3	1.3	-11%	93.2	11%	64.4	-42%	243.0	30%
4	1.3	-14%	94.6	15%	62.2	-51%	237.7	-23%
5	1.3	-12%	94.9	16%	62.4	-50%	240.0	0%
6	1.3	-11%	94.2	14%	64.3	-43%	240.8	8%
7	1.3	-13%	94.9	16%	63.6	-46%	238.3	-17%
Difference in	0.05		1.71		2.21		5.34	
P.2	1.3	-12%	94.4	15%	63.1	-48%	241.2	12%

Figure 45: The ramp-soak-spike reflow profile of SIM802

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